August/September, 1980
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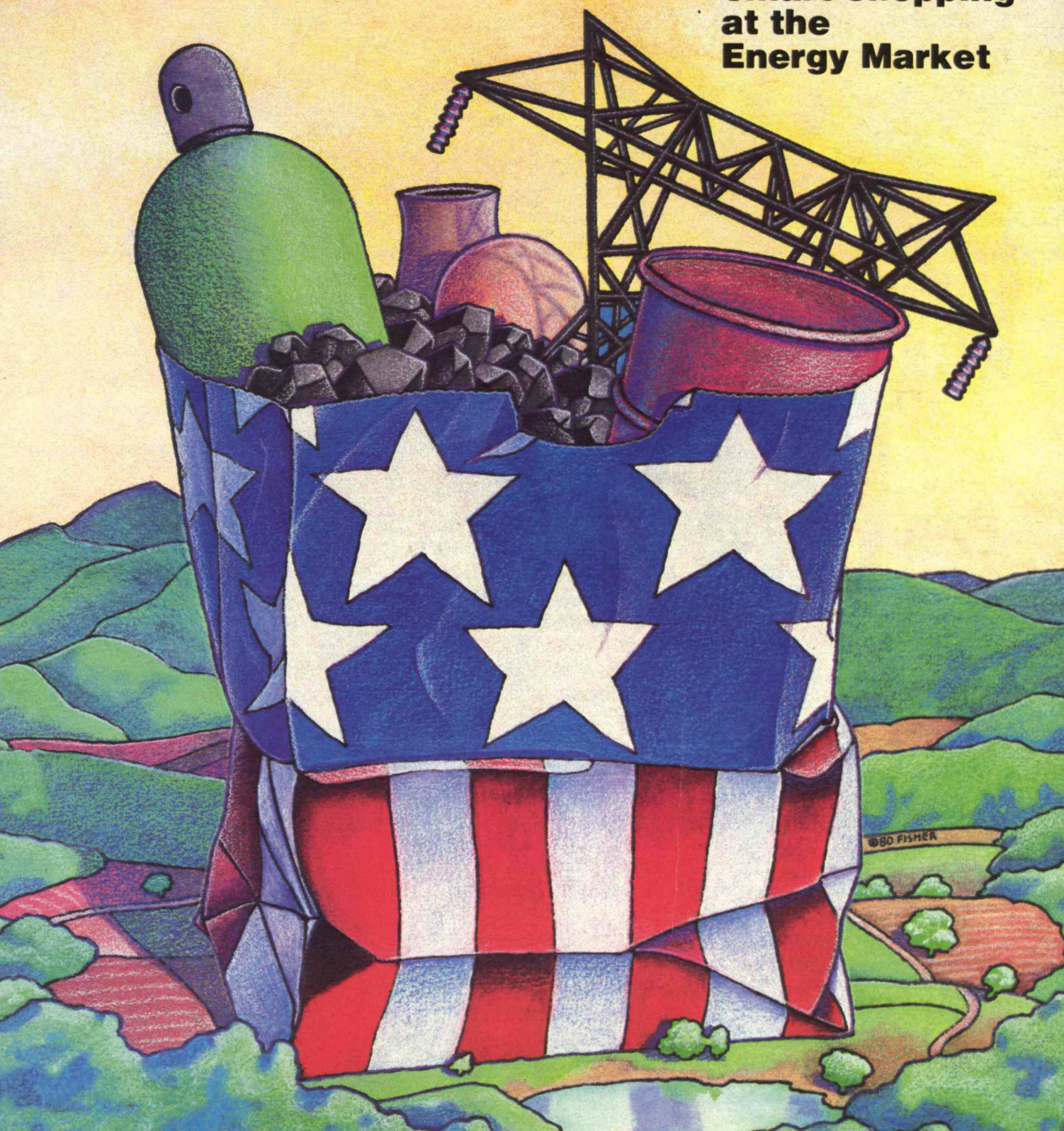
Laser Enrichment of Uranium:
More Fuel or More Bombs?
Speeding Up Mass Transit
Energy-Conscious Architecture
Vehicles and Fuel-Cell Power

Technology Review

Edited at the Massachusetts Institute of Technology

Smart Shopping at the Energy Market



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Need some help?

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The car you're looking at has a CIS fuel-injected engine that can take you from 0 to 50 in 8.5 seconds.

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And inside, there's room enough for a family of four.

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So why don't we just tell you.

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Of course, Autoweek had a different name for it.

They called it, "another winner from Volkswagen."

THINK AGAIN.

Edited at the Massachusetts Institute of Technology
Volume 82, Number 8
August/September 1980

Technology Review

Energy Choices for the 1980s
Page 30

Cover illustration by Mark Fisher
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FEATURES

18
Laser Enrichment of Uranium: Does the Genie Have a Future?
By Richard K. Lester
Whom do you trust — the sorcerer or the apprentice? An argument for American leadership in developing an economically attractive but politically risky technology.

30
Energy Choices for the 1980s
By David C. White
A resource-by-resource energy analysis — of what to use and when, where, and how to use it — given what we have and what we need.

42
Speed Is the Name of the Game
By Jack C. Page
In the urban transportation "marketplace," fast point-to-point service is the customer's commodity of choice. And with proper planning, the bus can outsell the car.

54
The Case for Fuel-Cell-Powered Vehicles
By J. Byron McCormick and James R. Huff
The preliminary assessment: quiet, nonpolluting, reliable, and easily maintained. But economic viability and on-the-road endurance must be demonstrated.

68
Rediscovering Energy-Conscious Architecture
By Selma A. Newburgh
What can Eskimoes, Filipino hut dwellers, and Turkish families in central Anatolia teach the designer of a Manhattan office building?

TREND OF AFFAIRS

80 **Energy** | 82 **Space Exploration** | 85 **Res Naturae** | 87 **Last Line**

COLUMNS

4
Society:
Kenneth E. Boulding
A society, to survive, must re-create its moral potential; or, maturity means never having to say you're stodgy.

6
Technology and Science:
Robert C. Cowen
Preparing for the uncertain effects of an atmospheric CO_2 buildup involves doing what needs to be done anyway.

8
Forum:
Steven D. Jellinek
A regulator's view of risk, compared with that of a scientist, justifies action under far greater uncertainty.

10
Environment:
Paul Langner
Hazardous wastes, long buried and forgotten, return to haunt communities with enigmatic questions of cause and effect.

12
Books and Comment
The Politics of Contraception, reviewed by Ruth Hubbard and Nancy Krieger; *The Fleecing of America,* reviewed by Edward Edelson

DEPARTMENTS

2 **First Line** | 2 **Letters** | 79 **Crostic**

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Fresh Faces

Two new names — those of Ellen Ruppel Shell and June Kinoshita — appear among *Technology Review*'s editors this issue, and their initials will soon become familiar and their influence evident to the *Review*'s readers.

Ellen Ruppel Shell studied biology at the University of Rochester (B.A., 1974) and then turned to writing — first on general assignment for *Upstate* magazine (of the *Rochester Democrat and Chronicle*) and then on science and engineering subjects for the University of Rochester's Office of University Communications. Ms. Shell wrote an assignment for the *Detroit Free Press* and other regional and national publications before coming to Cambridge in August 1979, where she promptly became a reporter for the *Cambridge Chronicle*. Now her keen sense of news and how to write it, supported by her science background, will benefit *Technology Review*'s national audience.

It's June Kinoshita's first post-baccalaureate job, but there's more to it than that. For a year in 1978-79, on a leave of absence from Harvard, Ms. Kinoshita worked as a technical assistant with a small experimental particle physics group at the Lawrence Berkeley Laboratory of the University of California; she also wrote about science, technology, and related social and political issues for the *Berkeley Monthly* and was staff science writer for the *Daily Californian*. Back at Harvard, Ms. Kinoshita ventured down to M.I.T. twice a week to study science writing with Professors Rae Goodell and John Wilkes; that's where we met her, and from then on it was simple. — *J.M.*

E. R. Shell J. Kinoshita

Deciding on Macroprojects

Your correspondent ("*Macroprojects and Macromistakes,*" *February, p. 76*) did not fully represent my response. Most macroprojects in developing countries are successful, well conceived, and competitive in future international economic markets. Unforeseen problems *and* benefits are normal, but social impact questions should be the prerogative of host governments.
Cordell W. Hull
Atherton, Calif. 94025

Regulating Carcinogens in the Workplace

In "Cancer, Inflation, and the Failure to Regulate" (*December/January 1980, pp. 42-53*), Samuel Epstein refers to a document, "Estimates of the Fraction of Cancer in the United States Related to Occupational Factors," prepared by the Department of Health, Education, and Welfare in September 1978; this is inaccurately described as prepared by experts from the International Agency for Research on Cancer (IARC).

While on sabbatical at the National Cancer Institute (NCI), Dr. N. Day of IARC was asked to write a statistical appendix to what he understood was a draft report being prepared for internal circulation in the NCI. At no time was he requested to comment on and approve the contents of the document; nor did he do so. It is the policy of this agency to publish the views of its staff in the peer-reviewed scientific literature or through its own publications, not to circulate them informally. Therefore, the views expressed cannot be ascribed to this agency or to any of its staff members.
John Higginson
Lyon, France

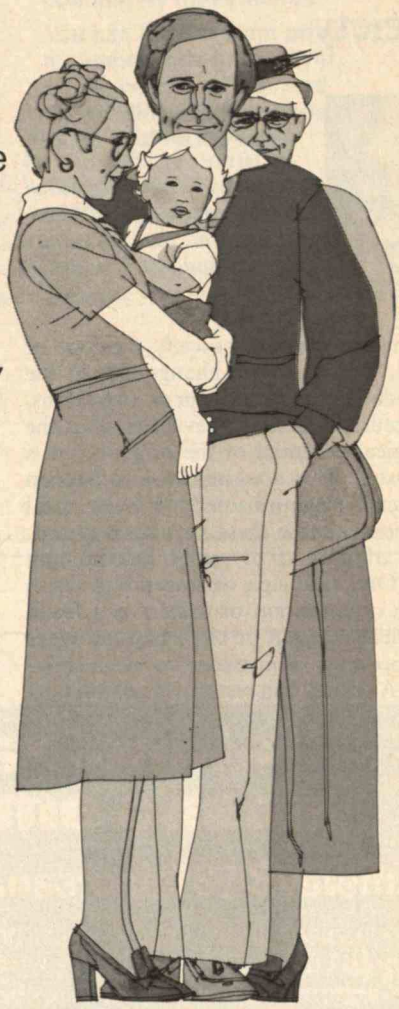
The writer is the director of the International Agency for Research on Cancer. —Ed.

Dr. S. Epstein's extraordinary misrepresentations and blanket criticism of industry overlook contrary examples, such as the fact that cancer risks from acrylonitrile at significant exposure levels were brought forward by industry, as was the association of heavy vinyl chloride exposure with employee cases of rare liver cancer. Responsible industry believes that risk levels should be properly assessed, and that cost and benefit considerations (for the nation) should be objectively evaluated before the political judgments

Continued on page 88

Who really owns Standard Oil (Indiana)?

62.95%
21,215 institutions, including insurance companies, retirement plans, colleges, estates, trusts, charities, foundations, banks, religious and fraternal organizations, etc.



29.59%
154,869 individuals

7.46%
Standard Oil (Indiana) employee savings plans.

Maybe *you* do. Maybe *you* participate in the company profits and don't know it.

If you are in a pension plan, or a union—or own an insurance policy, or invest in mutual funds—there's a good chance you have an interest in this company. Many Americans own its stock indirectly. In fact, about 63% of the company is owned by 21,000 separate institutions that represent millions of people. People like you who want their money to grow for their retirement and other future needs.

Plus that, about 155,000 private individuals own nearly 30% of its stock directly. And employees own more than 7% of the company stock through the company savings plans.

It's easy to picture an oil company as greedy and impersonal. But that image fades fast when you understand that it is millions of individuals like you who really own it. It is people who own the refineries, the pipelines, the tank trucks. It is people who risk their money on exploring for energy and drilling the wells that may or may not pay off. This is free enterprise.

Broad ownership through shareholding is something we can all be thankful for. Because it's shareholders who help provide the funds we continue to invest in America. To find the energy it needs. To help reduce America's dangerous dependence on foreign oil. And to strengthen America's economy so that people everywhere can prosper.

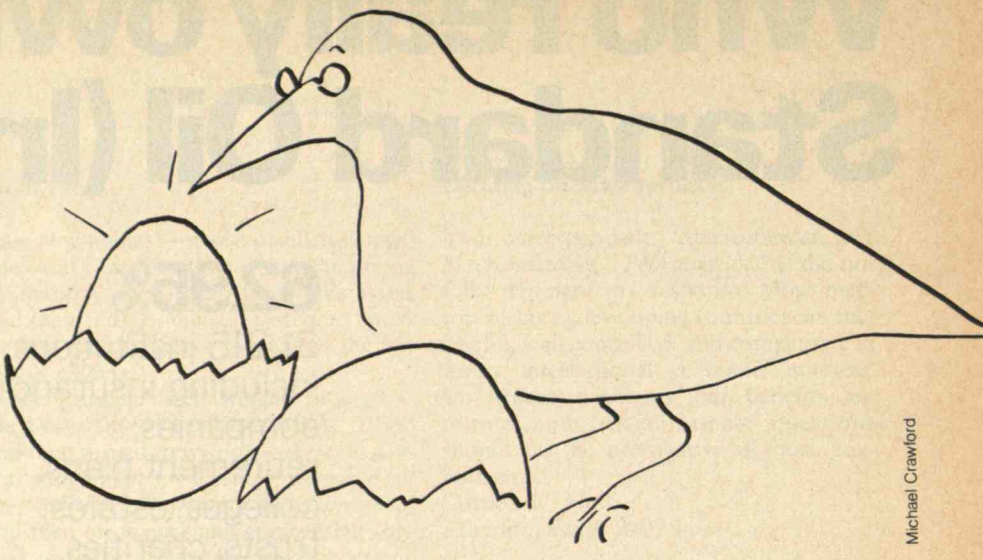
We feel that this investment in American energy is the best we can make. For America. For you. And for the millions of people like you who are the real owners.

America runs better on American oil.

Standard Oil Company (Indiana)

Toward a Vintage Society

Kenneth E. Boulding is a program director at the Institute of Behavioral Science and distinguished professor emeritus of economics at the University of Colorado at Boulder.



Michael Crawford

The maturation of our society, for good or for ill, will dominate change during the next decades. In biological organisms, senescence or death is inevitable when the biological potential of the original cell is exhausted. This does not have to happen in social organizations, or even total societies, because these structures are capable of a kind of social recombinant DNA. One sure sign of impending death for an organization or society is a fixed, uncritical worship of old ideas and ways that prevents adjustment to new situations. A society can restore its potential by replacing the old with the young in role structures and by developing "visions," renewals, and expansions of its original ideas.

Mediocrity and the "Brain Drain"

Signs of renewal in our own society come under three headings: material, intellectual, and moral. On the material side, the second law of thermodynamics pursues us relentlessly. Over the next hundred years, cheap oil and gas will certainly be gone, we may easily cut down more trees than we replace, many mines will be exhausted, and every person added to the total population is likely to diminish per-capita resources. There may be new worlds to conquer in space, but as far as Earth's resources are concerned, depletion is likely to rise and discovery to fall. Guarded pessimism seems appropriate.

The prospects are certainly better for intellectual potential. We are not putting as much into research as we should, but the research community is reasonably alive and well, and the prospects for creating new potential through increased knowledge are fairly cheerful. Nevertheless, even here there is occasion for disquiet. Universities are in serious trouble. One senses an increasing alienation of the academic community from the rest of society and especially from the political community. This is reflected in a growing mistrust, a demand for accountability that can easily be destructive (although it has some validity), and a certain lack of pride in the achievements of the human mind. At a moment when expanded intellectual efforts are necessary to offset depletion of resources, we are faced with doubt, hesitation, cutbacks, and a strange suspicion of excellence. Passion for equality, which has so long dominated our society — for the most part very fruitfully, is in danger of turning into a passion for mediocrity. In the history of our society, the pursuit of equality went uncomfortably hand-in-hand with the pursuit of excellence. Whether we can sustain this strange combination is perhaps one of the most critical questions for the future.

A further cause for anxiety is the "brain drain" into the war industry. We now have means of destruction whereby the civilian populations of virtually all countries are hostage to their own military. The more intellectual resources we put into the war industry, the more certain becomes our ultimate destruction. That a huge potential has been created for our own destruction is indeed the most alarming element of our present situation.

Signs of Hope

All this leads to the conclusion that the hope for our survival and betterment lies in the re-creation of moral potential. This new morality could be the cornerstone for the intellectual potential to offset the exhaustion of resources. Every subculture within a society creates an ethos that its members conform to, change, or flee from. Criticism of individual preferences is instrumental in changing human behavior. That is what constitutes the moral order and underlies the intellectual and material capabilities of a society. Both economic development and scientific advance are products of this underlying moral order: an unfavorable moral order can stop economic development and intellectual growth in their tracks. We have seen many examples of this in human history.

Are there any signs, then, of the renewal of moral potential in our society? Perhaps the most significant and hopeful architectural symbol is the wheelchair ramp, now in evidence across the country. Rising concern for the disabled, not merely sentimental pity, is one of the most encouraging signs of our time: the maimed, the blind, and the deaf have full minds and can realize their potential with fairly simple arrangements by society.

Affirmative action and ERA, even if not wholly effective, can also be interpreted as concern for the full realization of human potential. Another hopeful sign is our increased tolerance for homosexuality. Although this trait is a handicap in the transmission of genes, it should not prevent the realization of a full human life.

We have a long way to go in developing a fully integrated society from which no member feels alienated. There are residual problems of poverty subcultures, for example, and individuals whose development imposes high costs on the rest of society that seem intractable. The moral drive toward an integrated society, however, is strong, and one of the great intellectual tasks ahead is to learn to avoid the related frustrations.

Another aspect of maturation, of which we are on the threshold, is the development of a system of defense against unwanted change that is not also self-defeating. It is curious how little attention we pay to this problem in comparison with the problem of how to achieve desired change. Yet it is defense against unwanted change that creates some of the major pathologies of society and that is most likely to lead to its destruction. We see this particularly in the present system of unilateral national defense and the national image of being a great power. By far, the greatest threat to our society is nuclear war, the probability of which has

risen alarmingly in the last year. Our national defense has within it a certainty of destroying us all if the present system continues. Deterrence cannot be stable in the long run, and we must use the short-run stability to make the system genuinely stable. We have a model in the stable peace that characterizes, for instance, North America and Scandinavia. This is the only kind of successful national defense, but we may have a long way to go before we learn this.

There are signs of a radical transformation of our national image and our perception of the national interest. National interest is a variable of the international system, not a constant — it is a function of the national image. It has become increasingly clear in the twentieth century that being a "great power" is a cost, not a benefit.

A Transformation of Power

One of the great patterns of history is that wealth creates power and power destroys wealth, and oftentimes everything else. Part of the wisdom of maturity is a voluntary withdrawal from power, not into impotence, but into a realistic appraisal of the limits of the threat system. Power is most secure if based on an optimal combination of threat, exchange, and integrative relationships. It often takes a deep trauma to produce this transformation of power, but between Vietnam and Iran we seem to be experiencing this trauma now. One can hope that it will produce a profound reappraisal of our national image, especially of our place in the world.

"The progressive state is cheerful, the stationary dull, and the declining miserable," said Adam Smith. Perhaps he was too pessimistic, as thought John Stuart Mill, who looked forward to a stationary state regarding the growth of capital and riches. Eventually, of course, human potential may fail, and a society may lapse into a state that is declining and miserable. The demons of probability suggest that death lies in wait eventually for societies as well as persons. But societies are at least touched with the wings of immortality. With a bit of luck, wisdom, and good management, they can have a long period of gentle, creative, and happy, high-quality maturity. How to ensure this should be the highest priority of our intellectual effort. □

Coal and Climate: Stoking the Fires of Research

Robert C. Cowen, science editor of the Christian Science Monitor, *is former president of the National Association of Science Writers and a regular contributor to the* Review. *He holds S.B. and S.M. degrees in meteorology from M.I.T.*

Roger Revelle has an intriguing perspective on CO_2. "From the standpint of human beings," he suggests, "it's the most important substance on Earth; and you can say that without too much hyperbole." After all, through photosynthesis, carbon dioxide is the source of our oxygen, while carbon itself is the basis of life. Life on Earth would be quite impossible without CO_2 to absorb infrared heat radiation in the atmosphere. Lacking this warming effect, Earth's average temperature would be 30° C colder. And there would be no liquid water to support life.

This is worth remembering when strident alarms of climatic doom are raised over the possibility that increased use of coal could double atmospheric CO_2 and warm our planet a few degrees over the next 75 to 100 years. We aren't dealing with an exotic pollutant but with a substance essential to life. Moreover, the climatic effects of CO_2 doubling might not all be bad. Warming of a few degrees could, for example, give some dry regions more rainfall and better growing conditions. The more scientists study the CO_2 problem, the more many point out the uncertainties of climatic forecasting and focus on what the world should do to cope with possible CO_2-induced climatic change. That includes a number of things we should be doing anyway such as developing more efficient management of water supplies, more versatile and climatically adaptable agriculture, and alternative energy sources, especially renewable sources.

Not Whether, but When

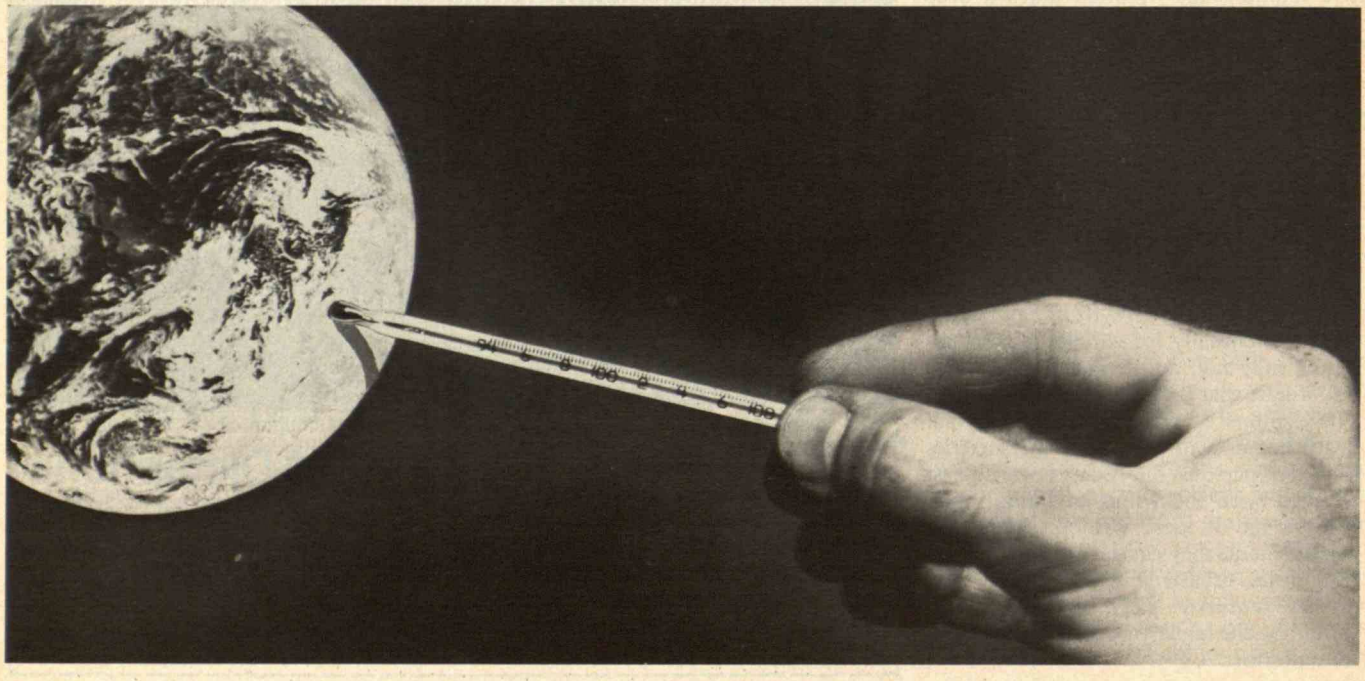
As leader of the American Association for the Advancement of Science (AAAS) Climate Project, Dr. Revelle must think through all aspects of the CO_2 problem and prepare a detailed guide for research into the possible environmental, economic, and social consequences. As Dr. Revelle explained in a recent session on possible consequences for agriculture in Third-World countries, study groups must face the fact that they are dealing with "uncertainty piled upon uncertainty."

To begin with, the amount of CO_2 added to the air from coal (and to a lesser extent from forest clearance) depends on the rate of world economic growth. If you assume growth rates of 3 percent a year or greater by projecting past trends, you foresee the kind of CO_2 accumulation often projected. But annual growth of 1 or 2 percent would delay the buildup, as would faster development of alternative energy sources. So the timing of any CO_2-induced climate change is uncertain.

Then, too, meteorologists don't know what happens to CO_2 in the atmosphere. Some of it disappears, probably into the ocean, with perhaps a little absorbed into the biosphere by plants. However, not all biologists believe the latter effect significant. Assuming the ocean to be the main sink, how much can it absorb? Again, no one knows.

Climatic change aside, more CO_2 in the air could benefit plants by acting as a fertilizer. From a human point of view, this would be beneficial only if it enhanced seed production. Most food staples are seeds (such as grains) and not leaves or stalks. Agronomists have shown experimentally that extra CO_2 enhances growth, but they don't yet know whether this boosts seed production as well.

Finally, what kind of climate change would a doubling of CO_2 bring? Certainly there would be a tendency to warm the lowest level of the atmosphere and increase overall precipitation. But some theorists have wondered whether various feedback effects, such as increased cloudi-



Ralph Mercer

ness, might cancel the warming trend. Some theories postulate a slightly warmer, moister climate as a trigger for glaciation; however, most are based on admittedly oversimplified computer models. These generally indicate an average warming of a few degrees centigrade, with somewhat greater temperatures in higher latitudes.

An empirical study by Douglas V. Hoyt, of the Cooperative Institute for Research in Environmental Sciences in Boulder, Colo., agrees. Dr. Hoyt studied how much CO_2 warming has already occurred by removing what he considers sun-related trends from temperature data for 1880 to 1970. This left a residual warming of about 0.4 degrees that could be due to CO_2. Although the estimate is uncertain, Dr. Hoyt notes that projecting a doubling of CO_2 indicates a further warming of two to three degrees, in line with the computer simulations.

Last year an ad-hoc study group of the National Research Council (NRC) reviewed all the model studies and concluded that, in spite of their simplicity, the projections should be taken seriously. The group reported that "we have tried but have been unable to find any overlooked or underestimated physical effects that could reduce the currently estimated global warmings due to a doubling of atmospheric CO_2 to negligible proportions or reverse them altogether. However, we believe it quite possible that the capacity of the intermediate waters of the oceans to absorb heat could delay the estimated warming by several decades. It appears that the warming will eventually occur, and the associated regional climatic changes so important to the socioeconomic consequences may well be significant, but unfortunately the latter cannot yet be adequately projected." For studies such as the AAAS project, there is justification for turning the CO_2 question on its head: take the warming trend as a given and ask what to do about it.

A Practical Agenda

One thing to avoid is running around warning that the Antarctic ice cap is going to melt and flood a lot of real estate. Some scientists have suggested that this could happen quickly — a highly speculative conclusion. As J.H. Mercer of the Institute of Polar Studies at Ohio State University pointed out, the projected warming could melt enough ice to raise global sea levels some five meters, but this would likely take several centuries. More sophisticated computer models should be developed, and it would be prudent to monitor the Antarctic ice by satellite regularly. Meanwhile, there's little merit in the "scare-the-hell-out-of-'em" approach typified by one prominent geophysicist, who stood on the U.S. Capitol steps indicating where the water would come to dramatize his case for restricting the use of coal.

Regional climatic effects were deemed hard to foresee by the NRC study. The model simulations, while vague, suggest that effects within any given latitude band, such as the temperate zone or subtropics, will be quite variable. Some regions will likely be better off than before. Last year, T.M.L. Wigley, P.D. Jones, and P.M. Kelly of the Climatic Research Unit at Britain's University of East Anglia compared the five warmest years with the five coldest from 1925 to 1974 to highlight possible patterns of change. For example, a warming of as little as 0.6 degrees (globally averaged) implies such striking changes as more rain in India and more dryness in central and southeastern United States, much of Europe, and the Soviet Union — changes which, the scientists note, "could have considerable impact on agriculture."

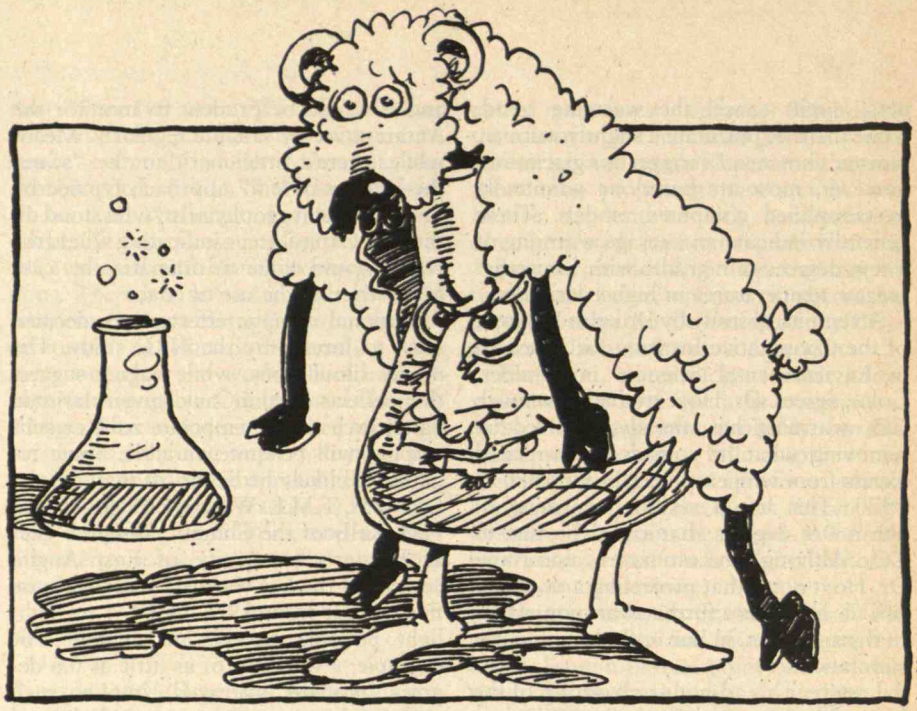
Three key points emerge. First, a global warming of a few degrees would probably benefit a number of countries, especially in the Third World. Second, if a nation such as India sees CO_2-induced climatic change as a blessing, why should it refrain from developing its own considerable coal reserves? Coal is the prime fuel for development in many Third-World countries — within a few decades, at least half the world's coal consumption will likely be in such lands. Thus, even if industrialized countries restrict coal burning, they may still have to learn to live with CO_2-induced climatic change. Finally, as the East Anglia study suggests, even the extremes of the present climate can put severe pressure on an overpopulated world.

The AAAS panel discovered that means to conserve and efficiently manage water supplies are already urgently needed (also true of the American dry areas). The gene pool of food plants needs to be assessed and preserved and the remaining forests, especially in the tropics, surveyed to find new useful plants to make agriculture more resilient and adaptable. And intensive research is needed to provide fast-growing trees for fuel-short countries to also ease the pressure to burn coal.

This agenda for research is aimed at this century, never mind 75 years from now. The CO_2 "threat," for all its uncertainties, is a spur to immediate action. □

On the Inevitability of Being Wrong

Steven D. Jellinek is assistant administrator for pesticides and toxic substances for the Environmental Protection Agency. This is an adaptation of a talk he gave in March to the New York Academy of Sciences workshop on Management of Assessed Risk for Carcinogens.



Jon McIntosh

The U.S. Environmental Protection Agency (EPA) administers two laws that require risk-benefit balancing: the Toxic Substances Control Act (TSCA), which gives the agency broad authority to control unreasonable risks of commercial chemical substances, and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), a pesticide registration law also aimed at protecting public health and the environment from unreasonable risks. These laws both involve what I call "the inevitability of being wrong," which explains why scientists and regulators approach chemical problems differently, and why a regulator's approach to chemical problems must be different from that of scientists.

Scientists tend to be cautious about accepting a new theory or evidence as valid. When confronted with a great deal of uncertainty, they avoid drawing conclusions, and instead call for additional careful study and research. There's always the chance that others may beat them to the result, but this risk is worth taking compared with being "wrong" or misleading the scientific profession. This approach is entirely consistent with generations of scientific tradition and training — hypotheses must be carefully developed, tested, and proven; cause and effect must be demonstrated.

Unfortunately, regulators don't have the luxury of putting off decisions until certainty arrives. Enormous scientific uncertainty surrounds the potential risks and benefits of most chemicals, yet these risks and benefits exist. Therefore, a regulator's every action — or inaction — represents a decision of some kind. Postponing action on a chemical until there is better information is a decision; taking precautionary action in the meantime is a decision; and delaying action because of limited resources or other priorities is also a decision. Whatever way they decide, regulators run the risk of making the wrong decision in the midst of pervasive uncertainty. The law of averages says that they won't be right every time. Therein lies the inevitability of being wrong.

Too Late to Act

If, for example, regulators decide to wait ten years until better data are in on whether chlorofluorocarbons deplete the earth's ozone layer, either the theory will be wrong and there will be no harm done, or the theory will be right and it will be too late to do anything about it. In the face of such uncertainty, should precautionary action be taken while science tries to find the right answers, or should more data be gathered to inform possible future action?

Let's consider the traditional 5 percent significance level. Scientists, as a rule, are uncomfortable with anything much higher than a 5 percent chance that their results are wrong. The lower the "p" value, the happier the scientists. The significance level is the probability of a false positive — the chance of a false alarm. A one in twenty chance is not very frequent; a one in ten chance is notably more frequent. From a public policy point of view, on the other hand, a "p" value of 50 percent — a one in two chance of a false positive — might sometimes be more appropriate, although many scientists would find this difficult to accept. But think about the matter from the regulator's point of view.

When it comes to toxic chemicals, the potential cost of a false negative (that is, insufficient precautionary action) may far exceed the potential cost of a false positive (too much precautionary action). Toxic effects are difficult to find, like needles in a haystack. Even after conducting an expensive test with a 5 percent chance of a false positive, there still could be a 50 percent chance of a false negative for a major effect deserving precautionary action. To resolve this difference in perspective, tests could routinely include analyses of the chance of a false negative. These calculations are currently scarce indeed.

Innocent Until Proven Guilty?

It is often said that it is possible to prove a positive but impossible to prove a negative, and therefore the burden of proof should rest on those who suspect a chemical to be carcinogenic or otherwise harmful. In other words, a chemical should be presumed innocent until proven guilty. If the evidence is suggestive but insufficient, there is a hung jury and judgment is "reserved." In this spirit, a recent *Science* article quotes a spokesperson for the chlorofluorocarbon industry as saying that the CFC depletion potential is still a "hypothesis," and no further precautionary action should be taken until there is conclusive proof. In placing a high value on civil liberty, we generally believe that acquittal of the guilty (false negative) is less harmful than conviction of the innocent (false positive).

But when toxic substances are involved, the idea of "innocent until proven guilty" does not make much sense. Granting civil

rights to chemicals may very well deny such rights to humans. Presuming chemicals innocent until proven guilty makes people victims unless they can sustain enormously difficult burdens of proof. To do so would also override the precautionary intent of TSCA and FIFRA. Rarely will there be overwhelming evidence of a hazard — the smoking gun or dead bodies — but the most obvious implication of this sort of proof is that we have waited too long to take precautionary action. Let me give you an extreme example.

Aggregate Risk

Our society's exposure to synthetic organic chemicals has increased exponentially in the last two decades. A number of these chemicals are known or suspected carcinogens, and in some cases we are now well into the latency period between exposure and onset of disease. Maybe nothing much will happen to cancer rates when these risks are expressed in the coming years. It's also possible that the rates will go way up. But how likely is it that age-corrected cancer rates will double, say, in the next two decades? You have to back a scientist against a wall to get an answer to this question. Unfortunately, it's the answer we need to think about if we are concerned about the right level of precautionary action.

If we don't ask questions about aggregate risk from the aggregate exposure of the last two decades, we'll have no way of thinking about what is the appropriate amount of aggregate precautionary behavior in the 1980s and beyond. For example, how far should we go in encouraging innovation away from the halogenated organic chemicals? What if they turn out to be "safe," and their substitutes clearly inferior? What if they don't, and we have done nothing about it? Such questions depend on our evaluation of the aggregate risk of present-day chemicals, in combination. And yes, they are very difficult to answer. But after all, the world has become a very uncertain place.

Explicit and adequate protection involves trading off the chance of the false negative against the chance of a false positive. It means acknowledging the risk of being wrong and balancing the potential harm. As we include protection against false negatives more actively in our decision making, we will move closer to achieving our broader public health and environmental protection goals. □

Uncertainty and the Law

The U.S. Supreme Court recently struck down a standard for occupational exposures to benzene in a ruling that may have far-reaching implications for the way regulators deal with risk.

Benzene, a known cause of leukemia and other blood disorders, is one of the most widely used industrial chemicals. The new standard, proposed by the Occupational Safety and Health Administration (OSHA), would have lowered permissible levels of airborne benzene from 10 ppm to 1 ppm, but the affected industries protested that the change would cost too much.

The Court skirted the thorny cost-benefit issue, however, and rejected the standard on the grounds that it was unjustified: Justice John Paul Stevens, writing for the majority, said that while the burden of proving a substance safe usually falls on "the party opposing the rule," the law also calls for OSHA to "bear the normal burden of establishing the need for a proposed standard." However, the Court concluded that OSHA had not even attempted to do so.

By law, OSHA must show that its benzene standard would remedy a significant health risk. OSHA has argued that any exposure to a carcinogen carries risk and should therefore be regulated to the limits of technological and economic feasibility. The Court, however, did not feel that evidence was sufficient to prove a significant health risk at 10 ppm, or that a 1-ppm exposure limit would provide a safer workplace.

While the Court's decision clarifies that burden-of-proof issue, other implications for OSHA's regulatory practices remain uncertain. The Court has not specified the range of scientific data and arguments it would consider acceptable, complicating the standard-setting process. But whether it will "render the federal government powerless" to protect workers, as Justice Thurgood Marshall warned in his dissent, remains to be seen. — *J.K.*

Hazardous Wastes: Ghosts of a Prodigal Past

Paul Langner covers science, energy, and the environment for the Boston Globe. *This article results from his recent investigation of the toxic waste problem in Woburn, Mass.*

Karen Watson

They reaped their harvests and left — the Monsantos, the Merrimacs, the Stepans, the Stauffers — chemical companies that for more than 100 years had kept North Woburn, Mass. busy and prosperous with industrial activity, making such products as glue, pesticides, and explosives.

They left behind tons of decaying hides and as-yet-unknown quantities of heavy metals and other pollutants, including hexavalent chromium and arsenic, a known carcinogen. Most of the land where their buildings once stood, about 120 acres, is now barren, a ruin of weathered foundations and a lone smokestack.

Less than a mile downwind in a neighborhood called Walnut Hill, the residents await October, when the Massachusetts Department of Public Health (DPH) has promised the results of a study to learn whether the unusually high rate of cancer in Woburn is associated with the wastes in the former industrial site. In 10 years, according to DPH statistics, Woburn should have had 503 cancer cases. It had 569, a 13 percent excess. Among them are 14 leukemia cases, 8 within a half-mile radius of one another.

For two weeks in June and July, interviewers from the DPH and the U.S. Center for Disease Control in Atlanta interviewed the parents of leukemic children and friends and relatives of 50 deceased Woburn cancer victims to determine whether there is a pattern of morbidity. But the residents suspect what epidemiologists already know — that it will be very difficult to link the repository of hazardous wastes with any pattern of illness revealed by the study.

Woburn is not Love Canal, where the chemical wastes dumped by the Hooker Chemical Co. in the 1940s are now seeping into cellars and oozing to the surface, and residents have experienced an abnormally high incidence of birth defects and other ills.

In Woburn, however, neither the wastes nor their links, if any, to the ills of the residents are so obvious or dramatic. Because the connection is so tenuous, Woburn is apt to become a paradigm for the toxic-waste problem that, in the last three or four years, has moved toward the center of national consciousness. There are thousands of abandoned waste dumps across the nation, most of them near or even within populous cities and towns, and we are only beginning to evaluate the hazards they may represent.

The Disinherited

The dumps are orphans, deposited on the public's doorstep by industries that out of ignorance, sloth, or financial necessity failed to dispose of their wastes properly. Ironically, despite the wealth generated by more than a century of exuberant industrial activity, the public seems unable to find the resources necessary to understand and deal with the residue.

The Massachusetts Department of Environmental Quality Engineering (DEQE) has had to scrounge for funds to perform even simple tests on the Woburn arsenic and chromium pits. And when Richard Leighton, an engineer with DEQE, tried to put up a fence to keep unsuspecting people of out of the area, he was able to raise only $200 — enough to buy a roll of single-strand barbed wire. With the help of some juvenile offenders in a work-release program, he strung the wire himself.

William D'Annolfo, a real-estate developer who with some partners bought the Woburn land in 1968 for development as an industrial park, has now run up against a seemingly intractable problem. Every time he puts a backhoe or a bulldozer to work, he unearths piles of rotting hides that send hydrogen sulfide odors — the familiar rotten-egg smell — into Woburn and neighboring Reading. Cleaning the arsenic pits and chromium lagoons seems beyond his resources. Just to do an engineering study, he says, will cost him $100,000. According to one independent estimate, the cost of safely removing the arsenic and chromium and trucking it to a disposal facility would come to $6 million. D'Annolfo has said he

might just walk away from his land if the price of cleaning it up turns out to be too high. The poisoned land would then revert to the city of Woburn, an orphan once more.

Dragon's Teeth

According to the U.S. Environmental Protection Agency, cleaning up all the known and suspected abandoned hazardous waste dumps in the nation could cost as much as $54 billion, a sum that no public agency is likely to raise. And industry does not consider itself liable. When manufacturers dumped their toxic wastes, no law forbade them to do it, and it is possible that much of the dumping was done in innocence by those who did not know they were sowing dragons' teeth. But in the case of Woburn, complaints date back to the 1860s, although apparently they had little effect.

Even today, Congress is running into heavy lobbying from the chemical industries as it debates a so-called "superfund" bill that would impose a tax on industrial products to provide about $1.9 billion toward cleaning up the wastes.

And just as environmentalism is practically a religion, industry often preaches the rival faith of risk-benefit analysis. But an increasingly suspicious and hostile public may force industry to change its attitudes. "Spare me your risk-benefit analysis," said one Woburn resident when the subject was raised at a recent public meeting. It would seem that for the affected community, the concept carries little moral or political clout.

As suggested in these pages by Nicholas Ashford [*"The Limits of Cost-Benefit Analysis in Regulatory Decisions," May 1980, p. 70*], benefits are difficult to measure in economic terms. They may include such things as better health and an improved environment, "but they defy accurate estimation and their recipients are not a well-organized lobbying group." To which Anne Anderson of Woburn would emphatically say, "Amen."

For years she had been telling her clergyman, the Rev. Bruce Young, rector of Trinity Episcopal Church, that she suspected something in the water had made her son ill with leukemia. Rev. Young was skeptical at first, even when she told him of other leukemia cases in his parish and nearby. Only when Woburn police, responding to an anonymous tip in May 1979, found 183 barrels of solvents dumped illegally in the new Woburn industrial park did things begin to happen.

Tests of two wells near the dump site showed them to be contaminated with the solvent trichlorethylene (TCE), a suspected carcinogen. The wells were closed, but what puzzled the DEQE was that none of the barrels contained any TCE. Further testing on the site turned up arsenic, chromium, and other heavy-metal residues.

Neither Mrs. Anderson nor Rev. Young had been aware of those residues, but the discovery opened the clergyman's eyes. He called a meeting of his parishioners and asked if anyone knew of other leukemia cases. In time he was able to document eight cases, and he took his data to Dr. John Truman of Massachusetts General Hospital, who in turn alerted the Center for Disease Control (CDC) in Atlanta. The current study resulted from the collaboration between the CDC and the state health department.

Dread and Defiance

Before these events, the industrial site had been only a big nuisance, generating the notorious Woburn odor first noticed in 1976 when D'Annolfo's contractors dug into the buried hide piles and released the hydrogen sulfide. Now a dread has settled over the city. Some residents have taken to wearing black T-shirts printed with a skull and crossbones and bearing the legend: "Caution — Woburn may be hazardous to your health."

There are others who defiantly assert that they know of 90-year-olds who have lived in Woburn all their lives without getting sick; those who worry in public about the arsenic and chromium deposits are only giving a thriving and attractive city a bad name, they say. But their truculence belies their concern. Something has awakened after years of quiescence: the cycle of development, prosperity, and decline has terminated in an unknown menace. □

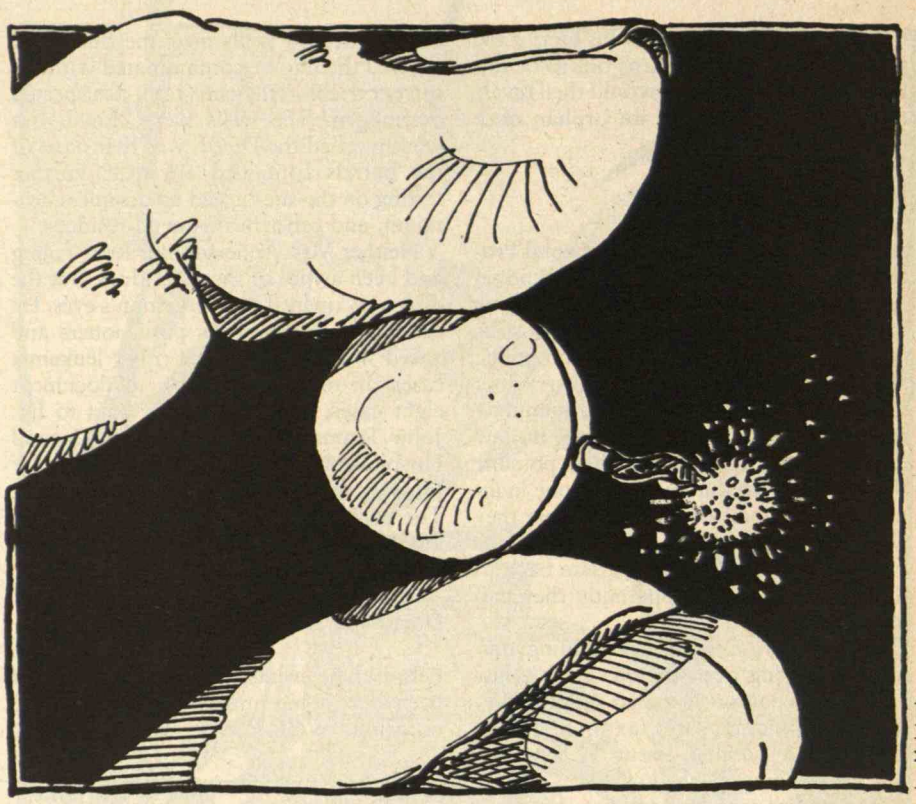
We welcome contributions from our readers to Forum and Special Report. Queries should be submitted to the Forum editor, Technology Review, *Room 10-140, M.I.T., Cambridge, MA 02139.*

The Pill and the Pendulum

The Politics of Contraception
Carl Djerassi
New York: W.W. Norton, 1979, $10.95

Reviewed by Ruth Hubbard and Nancy Krieger

"In a period of less than 20 years, the Pill has become the most significant hardware component in man's contraceptive armamentarium."



Jon McIntosh

These warrior words are typical of the language and thinking of this book, whose author is so wedded to technocratic jargon that he does not even seem to notice the humor in calling condoms "hardware." Indeed, he calls all "actual means of birth control" (including such social customs as coitus interruptus) "hardware." "Software," by contrast, is "all the complicated social, cultural, political, religious, and legal issues that must be dealt with before any 'hardware' research can be implemented."

The Larger Politics

Rather than the "global perspective" promised on the cover, the book presents a narrow view of the politics of contraception as they affect a U.S. industrialist who tries to develop marketable products and in the process does battle with competitors, consumer advocates, and regulatory agencies.

For many years and in many forums, Djerassi has argued that exaggerated concerns about safety and intolerance of "side effects" make it unprofitable for drug companies to put money into research and development of new contraceptives for women and men, and that if the present climate had existed in the 1950s we would not have gotten the Pill (always spelled with a capital P). His point is that further innovation will require government subsidization of the pharmaceutical industry. To evaluate this suggestion, the reader must be aware that Djerassi is not just the "great chemist" and "first-rate scientist" described on the dust jacket, but also a spokesperson for that industry. By his own description, he converted Syntex from a small, unknown research firm to one of the world's major pharmaceutical houses, and among whose main products are hormone contraceptives.

To put this book in context, we need to look at the larger politics of contraception that, despite its title, Djerassi's book fails to discuss. Politics determine who develops contraceptives, on whom they are tested, for whose use they are intended, and the circumstances in which they are actually used. Politics also dictate various systems of dependency: Third-World nations on U.S.-produced pharmaceuticals, and users of birth control on providers, even to the extent that expert advice regulates sexual practices. Politics even determine which changes produced by chemical contraceptives are credited as "effects" and which are dismissed as "side effects."

The overriding political issue is who controls birth spacing — the rate of reproduction. To understand this it is important to distinguish between birth control and population control. Djerassi never makes this distinction — he may not even be aware of it — and therefore his discussion is muddled. (For a very readable historical treatment, read Linda Gordon's *Woman's Body, Woman's Right*). Birth control is control over one's own reproduction, and hence must be in the hands of the people who are having (or not having) children. Birth control movements have generally been led by women's rights activists who see it as a liberating and indeed essential component of women's equality. Population control implies control over other people's reproductive lives by the state, agencies, or other professionals — *denial* of reproductive rights. This is not to say that population controllers do not sometimes give people access to means of birth spacing that they want and need, but this is incidental. According to the controllers, the issue is not what people want but what they must have to curb population increases.

Djerassi cites contraceptive use as prima facie evidence of "demand." As supporting data, he cites sterilization frequency, IUD insertions, and use of hormone contraceptives. He writes that in the United States among white populations, sterilization is almost equally divided between males and females, whereas among blacks the ratio is at least ten to one in favor of women. In Puerto Rico, where female sterilization is frequently referred to as *la operacion,* men hardly ever undergo sterilization.

Who would guess from this that in the U.S. and Puerto Rico, black and other Third-World women have formed organizations to agitate against sterilization abuse and to warn other women about it? Or that more than one-third of Puerto Rican women of reproductive age have

been sterilized, as have a disproportionate number of American Indian women? Or that some U.S. physicians have been convicted in court of sterilizing women on welfare against their wills?

In a similar way, Djerassi refers to "an explosion in elective hysterectomies among affluent women in the United States," as though women "elect" hysterectomies. Nowhere is the qualification that hysterectomy rates are much higher in fee-for-service than prepaid insurance plans, nor a discussion of the common attitude among physicians — publicly expressed by a vice-president of the AMA — that hysterectomy is a proper procedure "to relieve anxiety" about cancer or unwanted children.

She Can't Say "No"

In the chapter on the Pill, Djerassi again implies repeatedly that women, particularly poor women and women in "lesser-developed countries," are using the Pill as the result of a free choice among alternatives with intelligible information about the pros and cons. But surely he must know that in U.S. clinics the Pill is often the only contraceptive women are offered (unless they are given IUDs), often without adequate medical examinations, warnings, and easy access to medical help if untoward symptoms develop.

Djerassi never discusses why the Pill was tested in Puerto Rico, though developed in the U.S. As pointed out by Gena Corea in *The Hidden Malpractice,* "The Food and Drug Administration approved (the Pill's) sale to American women on the basis of studies on only 132 Puerto Rican women who had taken the Pill consecutively for 12 or more months and 718 other women who took the Pill for less than one year. Five of the women died. No doctors from the study examined the women during their illnesses." Djerassi does mention in passing — without comment — that Japan still has not approved the use of the Pill. He does not point out that "the Pill is the best contraceptive method currently available" because the "side effects" are underrated. What are the possible ramifications of perpetually maintaining a woman's hormonal system at pregnancy levels — the effect of the Pill?

One reason the Pill is popular is that all "available" methods are poor. But relatively small amounts of money support the development of less invasive "barrier" methods — condoms, sponges, cervical caps, and diaphragms. These devices would be much more effective if they were less disagreeable to use: for example, if they were saturated with spermicides so messy jellies and foams were not needed.

Djerassi neglects to ask innovative questions such as what would happen if contraceptive research were a joint enterprise of experts and users, in which the users had the necessary information and participated in the important decisions. This leads to another question: Should not the research subjects be people already motivated to space births and sufficiently assertive to insist on genuine partnership in the research process, who also have a maximum number of real choices — college-educated American women and men? As it stands now, the research is done on poor and uneducated people, who experience only minimal choices in all spheres of life, including birth control.

Djerassi knows that people are railroaded by population controllers and approves of this practice. He urges the development of IUDs that can be inserted "immediately after a woman delivers a child or has an abortion," since "clearly these are two times when [she] might be most receptive to contraceptive advice." This would be useful "especially in developing nations, [where] they may be the only times that she visits a hospital or clinic" or "is seen by medical or paramedical personnel." Surely he must know the dangers of such practices: women who do not have ready access to medical personnel suffer "side effects" that can lead to permanent damage and even death, when IUDs are not removed promptly by trained people when necessary. In spite of these risks, and under sponsorship of U.S. population control programs, IUDs have been inserted in poor women living far away from health care facilities in the Philipines, for example. In India, women desperate for money have been offered a bonus for getting an IUD, leading to the extremely dangerous and sometimes fatal practice of pulling out their IUDs themselves to be eligible for another bonus.

With all Djerassi has to say about the Pill and the IUD, there is no discussion of the fact that they have been designed, produced, and usually administered by men, who will never experience them. Surely this is part of the politics of contraception, one reason why these contraceptives are a good deal more "liberating" for men than for women. For men, these inventions have truly severed the link between heterosexual intercourse and procreation, thus relieving them of responsibility for conception, while women, supposedly liberated, have been denied the oldest excuse to say "no."

Reproduction and its control are both political and personal. How best to regulate reproduction is not merely a technological problem that can be solved with the right mix of "hardware" and "software." Outside the Brave New World, it is and must be a personal decision inextricably linked to social and political policies. All that outsiders can do (and professionals are outsiders in all but their own situations) is to provide individuals with contraceptive means; whether these are usable or useful options can be decided only by the users. Djerassi, like too many other technocrats, believes that technical expertise entitles him to determine what is best for people. Therefore, the book is filled with resentment and anger at those who do not accept the Pill and other systemic contraceptives (e.g., Depo-Provera, an injectable drug not approved by the FDA for use in this country but distributed via U.S. subsidiaries to over 60 foreign countries) as the best forms of birth control.

The book ends with a peculiar and rather technical postscript that attempts to show how Djerassi's team at Syntex won the "race" to produce cortisone and how he, rather than "the late Gregory Pincus," deserves credit for fathering the Pill. But apart from the chapter on "Birth Control in China," in which Djerassi summarizes information he collected on a trip in 1973, the book is not very informative or interesting.

Ruth Hubbard is professor of biology at Harvard University. Nancy Krieger is a recent graduate of Harvard/Radcliffe in biochemistry now working in an occupational health program of the Oil, Chemical, and Atomic Workers' Union. □

When Ignorance Is Blitz

The Fleecing of America
William Proxmire
Boston: Houghton Mifflin Co., 1980, $10.95

Reviewed by Edward Edelson

The only conceivable reason for anyone to read this book is to gain insight about Senator William Proxmire's views and knowledge of science. These are important because Mr. Proxmire has begun to

influence federal spending on scientific research. For five years, he has been making what he calls Golden Fleece Awards to dramatize waste in the federal budget. Those awards have been given to scientists for what are described as foolish projects not worthy of funding. The object is to improve the efficiency with which money is spent on research. Since Mr. Proxmire is a senator, funding agencies tend to be influenced by what he says.

The senator's goal cannot be criticized. A great deal of money undoubtedly is spent on unworthy research projects; one need only ask scientists whose grant applications have been denied. Knowledgeable criticism could help prevent such waste. *The Fleecing of America* tells us just how wise and knowledgeable Senator Proxmire's criticism is (or is not).

As a work demanding thought from the writer and reader, the book's value is nonexistent. Rather, it is a collection of stump speeches and press releases combined as one hooks together the cars of a toy train. There is no sense of proportion: Two pages are spent in a denunciation of a $6,025 grant to an artist by the National Endowment for the Arts. One page is spent on a denunciation of the government's decision to build 13 aircraft carriers at a cost of $39 billion. A list of all such disproportions would weary the reader.

Locker-Room Humor

The English language has a large number of phrases ready-made for the lazy writer when thought becomes fatiguing — this book uses most of them. What is the burden of spending? Immense. What is the federal deficit? Massive. What is the national debt? Swelling. How does public revolt come out? Loud and clear. How did Proposition 13 win? By a smashing two to one.

This kind of writing hurts the senator's case because it numbs the mind to the point he is trying to make. Reading more than 200 pages of this crude prose is like watching two hours of television commercials. When everything is denounced with the same brutal monotony, it becomes extremely difficult to distinguish true abuses from imagined ones. For example, it is entirely possible that the Federal Aviation Administration was unwise to spend $57,800 to study the physical measurements of airline stewardesses. Mr. Proxmire points out quite rightly that while the information might be useful for aircraft designers, the study could just as well have been paid for by airlines and aircraft manufacturers.

But the senator uses the same kind of locker-room humor he expends on the airline study to ridicule the expenditure of $89,000 by the Smithsonian Institution for the production of a dictionary of a dialect of Tzotzil, an unwritten Mayan language of southern Mexico. And here we come to the essence of what the book tells us about William Proxmire: He has absolutely no understanding of the spirit or purpose of scientific research.

The Poverty of Ignorance

In the case of the Tzotzil dictionary, Mr. Proxmire reprints, with heavy jocosity, the statement by the author that the book "will collect dust on library shelves." He also prints, as an accusation, the author's statement that he spent ten years "in museums and on mountain trails, shivering in icy San Cristobal rooms and basking beneath a Zincanto sun."

The senator's interpretation is that someone has chosen to spend years in an uncomfortable part of Mexico simply to cheat the federal government out of $89,000. There is no recognition of the scientific value of the project, because Mr. Proxmire does not seem to know that scientists are interested in dictionaries of obscure languages. What anthropologists would describe as a disinterested search for knowledge about one aspect of the human race Senator Proxmire recognizes as no more than a scam. Ignorance, not stupidity, prompts such mistakes. The senator was wise enough to lead the fight against the supersonic transport, and he is an intelligent critic of military waste, but he is ignorant about science.

Two more examples will suffice. Mr. Proxmire praises the National Science Foundation for three activities. One is "work to build a man-made working gene, the basic chemical unit which, in combination, controls the growth and development of all living things." A second is "methods of improving on nature's way of replenishing nitrogen in the soil." The third is "research on how the brain recovers after being damaged."

Numbers Misinterpreted

What can one say about this overblown and unrealistic list? Somehow, of all the projects sponsored over many years by the National Science Foundation, these three have filtered through to the consciousness of William Proxmire. To find out how this happened would be a fascinating study of the public perception of science.

Senator Proxmire supports the theory that basic research does not contribute to economic advancement with a statement that Japan and Germany are outstripping us economically even though we outspend them on research and development. His documentation, however, is a table that shows that as a percentage of GNP, these countries in fact outspent the U.S. Research and development funding declined from 2.74 percent of the U.S. gross national product in 1961 to 2.25 percent in 1977. The German GNP rose from 1.25 percent in 1962 to 2.26 percent in 1977; the comparable increase in Japan was from 1.39 percent in 1961 to 1.94 percent in 1976. One wonders whether Mr. Proxmire looked at the numbers when he wrote the words.

Court Costs

We must resist the temptation to ridicule Mr. Proxmire the way he ridicules scientists. His active intelligence is not accompanied by adequate understanding and information. He should find time in his schedule to listen to people who can tell him what science is about: why scientists do what they do, why seemingly foolish projects sometimes should be given money, what the spirit of the scientific endeavor really is. Fortified with this knowledge, he could become a truly effective critic of wasteful spending. Instead, he is a deadweight on scientific research in the United States.

The parallel between two stories in the book does not seem to have struck its author. One is of Ernest Fitzgerald, who was shunted aside because he gave accurate criticism of mistakes in the building of the C5A cargo aircraft. Fitzgerald went to court and, after a legal fight in which hundreds of thousands of dollars were spent over several years, won his job back. Senator Proxmire laments the fact that Fitzgerald's critics still prevent him from doing a meaningful job.

The other story is that of Ronald Hutchinson, a psychologist who was given a Golden Fleece Award for his work on aggressive behavior, suffered grave losses, and spent hundreds of thousands of dollars in court to win redress. Early this year, Senator Proxmire paid Hutchinson $10,000 in damages and $5,132 in court costs. He issued a statement that said in part:

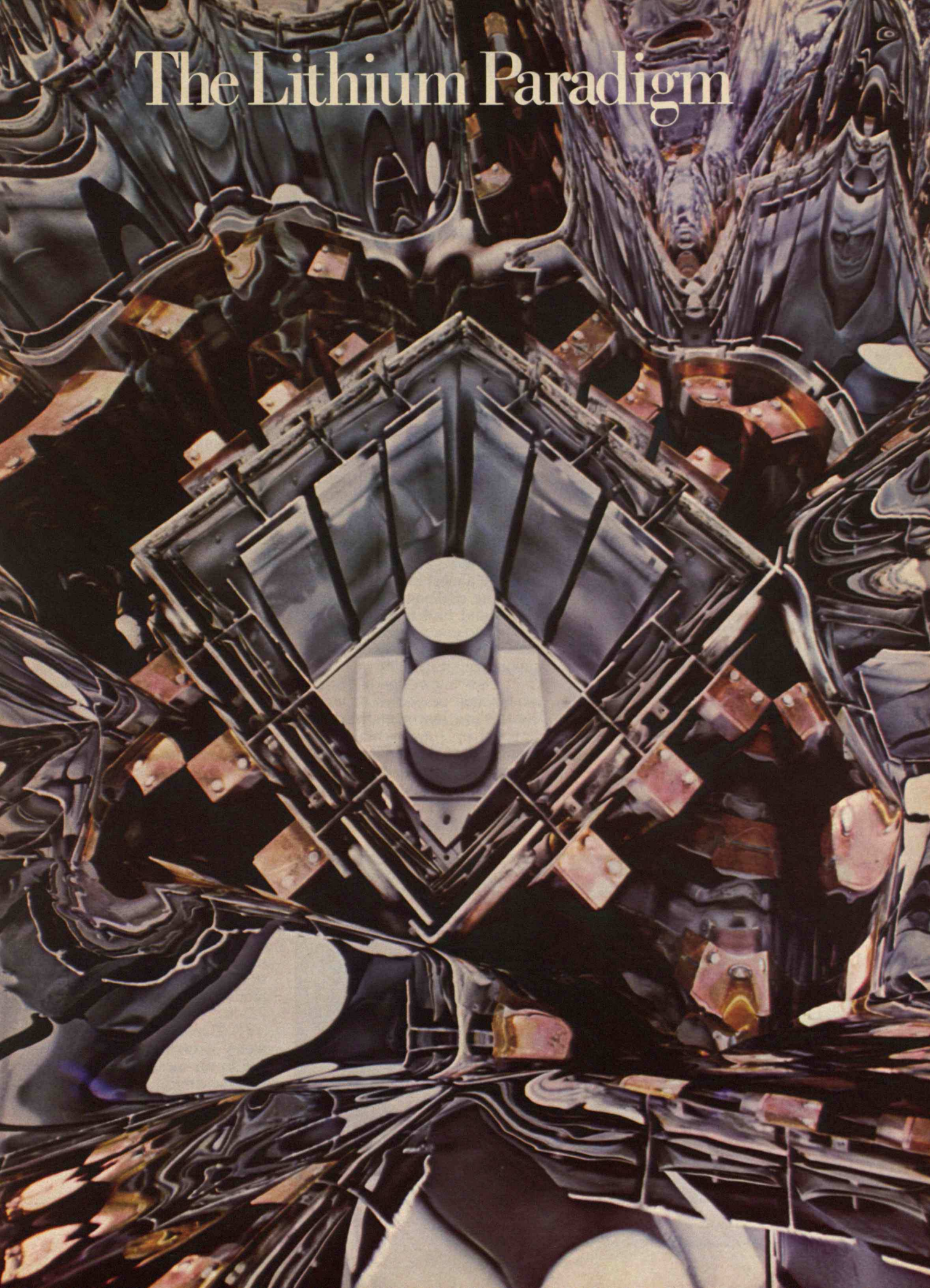
"I stated that Hutchinson's projects were extremely similar and perhaps duplicative. I know of no evidence that Hutchinson ever received extra money for work that duplicated earlier work that had already been funded.

"I stated that Hutchinson made a fortune from his monkeys. While the amount of federal expenditure was large and provided support for Hutchinson's research for a number of years, the fact is that Hutchinson never made a personal fortune."

The cost of Mr. Proxmire's unsuccessful legal defense, about $125,000, was paid by federal funds (albeit funds Proxmire plans to reimburse with the royalties from this book). Three days after the settlement was announced, Senator Proxmire released another Golden Fleece Award.

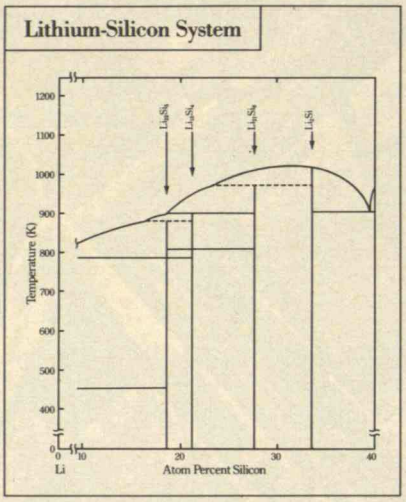
Edward Edelson is the science editor of the New York Daily News. □

The Lithium Paradigm



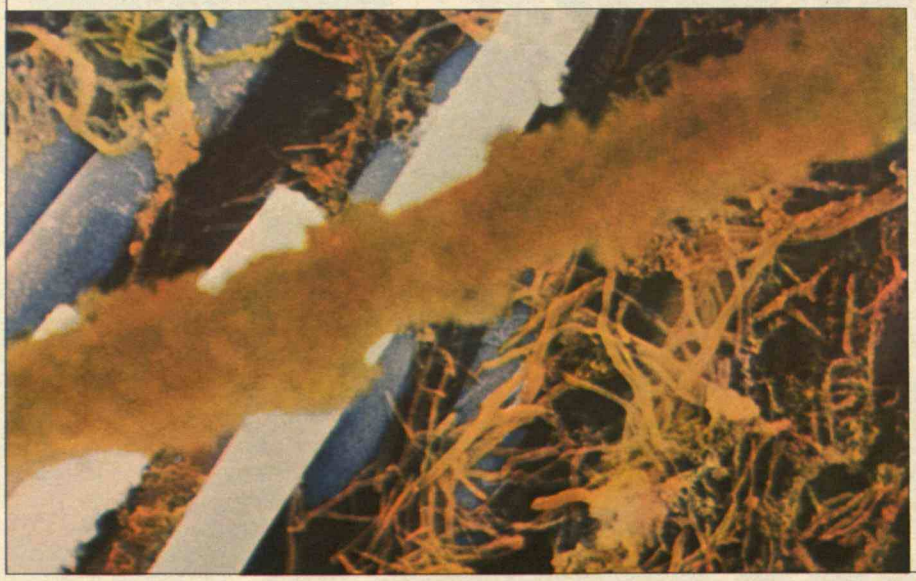
The Lithium Paradigm

The practicality of a mass-produced electric car depends upon the development of a long-life, low-cost, rechargeable battery. Recent discoveries at the General Motors Research Laboratories have encouraged scientists seeking to harness the abundant but elusive energy available in lithium—a highly desirable battery component.



Partial phase diagram of the lithium-silicon system. Lithium activity changes by two orders of magnitude in the concentration range shown.

Color-enhanced scanning electron micrograph showing the results of lithium attack on boron nitride.



HIGH ELECTROPOSITIVITY and low equivalent weight make lithium an ideal battery reactant, capable of supplying the specific energy needed to operate an electric vehicle. The source of the abundant energy available in lithium, however, is exactly what makes it almost impossible to manage. The challenge is to prepare alloys and find materials stable enough to contain the aggressiveness of lithium without greatly suppressing its activity.

New knowledge of the thermodynamic properties of lithium-containing materials has been revealed by fundamental studies conducted at the General Motors Research Laboratories. Investigations, carried out by Dr. Ram Sharma and his colleagues, aim at developing a basic comprehensive understanding of selected "exotic" systems. Their work is directly related to the search for an advanced molten salt battery cell.

Specific energies greater than 180 W·h/kg, about five times that of the lead-acid battery, have been demonstrated by electrochemical cells utilizing LiCl-KCl electrolyte and electrodes of metal sulfide and lithium alloy. But operating temperatures of 723 K and the aggressive nature of the chemical reactants pose serious new challenges to cell construction materials. Of particular concern is the lithium attack upon separators and seal components. Most inorganic insulators, including the refractory oxides and nitrides, are destroyed or rendered conductive by this attack. Boron nitride, one of the more resistant materials, has been the subject of Dr. Sharma's recent, successful efforts to establish conditions under which attack may be avoided.

Dr. Sharma began by exploring the thermodynamics of the lithium-silicon system. Silicon reduces the activity of lithium without substantially increasing its weight, and produces a manageable solid at 723 K.

Constant-current potentiometry experiments were carried out in an inert atmosphere. The electrochemical cell consisted of a Li-Si alloy positive electrode, a eutectic mixture of LiCl-KCl electrolyte, and two Li-Al alloy electrodes—one negative and one reference electrode.

A series of anodic and cathodic cycles at very low current densities indicated three well-defined voltage plateaus below 80 atom percent lithium composition. This behavior was confirmed by experiments in which pure silicon was used in place of Li-Si alloy as the starting material.

The results were used to modify the Li-Si phase diagram, which indicated only two such plateaus. The revised phase diagram shows four compounds: Li_2Si, $Li_{21}Si_8$, $Li_{15}Si_4$ and $Li_{22}Si_5$. The exact composition of $Li_{21}Si_8$ had not previously been known.

Dr. Sharma confirmed the existence of the new compound by x-ray diffraction analysis. He determined its melting point to be 976 ± 8 K by differential thermal analysis. He produced a scanning electron micrograph that clearly indicates a single phase for the compound. He was also able to determine the maximum nonstoichiometric ranges of the lithium-silicon compounds from charge passed during the transitions between voltage plateaus.

KNOWLEDGE OF THE lithium activity present in the system's various compounds allowed Dr. Sharma to evaluate the stability of boron nitride with Li-Si alloys of differing composition.

A controlled potential was imposed on a boron nitride cloth sample in an electrochemical cell. By monitoring the current in the cell at different potentials, Dr. Sharma established the point at which lithium activity produces reaction.

Boron nitride was found to react with $Li_{15}Si_4$ only when in the presence of $Li_{22}Si_5$. The new compound, $Li_{21}Si_8$, did not exhibit sufficient lithium activity to attack boron nitride.

Reaction occurred according to the following equation:

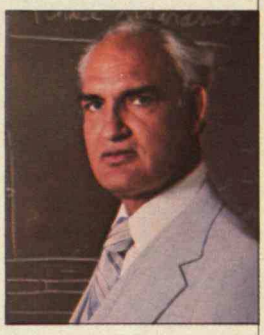
$$BN + (3+x)\,Li = Li_xB + Li_3N$$

The lithium nitride that formed during reaction dissolved in the molten salt electrolyte, but the lithium boride remained on the surface and became electronically conductive, causing high self-discharge in the cell.

"The establishment of the region of stability of boron nitride makes it possible to recommend appropriate charging limits," according to Dr. Sharma.

"Restricting the amount of charge in keeping with the recommended limits will control lithium activity, preventing the formation of highly-conductive compounds and adding durability to an electrochemical system which already displays high specific energy. Ultimately, that brings the prospect of high-performance electric vehicles closer to reality."

THE MAN BEHIND THE WORK



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Dr. Sharma was educated in India and England. He graduated from Banaras Hindu University with an M. Sc. in physical chemistry. He received a Ph. D. in physical chemistry and chemical metallurgy from London University's Imperial College of Science and Technology.

Before joining General Motors in 1970, Dr. Sharma conducted research at the Argonne National Laboratory, the Institute of Direct Energy Conversion at the University of Pennsylvania, the Nuffield Research Group in England and the National Metallurgical Laboratory in India.

Laser Enrichment of Uranium: Does the Genie Have a Future?

by
Richard K. Lester

This new technology may be an economic bonanza for nuclear power. But will it also add to the dangers of nuclear weapons proliferation?

A new class of technologies for enriching uranium with lasers has been under development in the United States for almost a decade, with remarkably little public discussion. So far, over a quarter of a billion dollars, much of it public funds, has been spent on the development of various laser-enrichment processes. Roughly twice again as much will be required to bring even one of these techniques to the point of large-scale production. What are the economic prospects for these new technologies? What are the associated risks? Are further major expenditures justified? How might these technologies affect the nuclear policies of the United States government?

Naturally occurring uranium consists almost entirely of the isotope ^{238}U. Only about 0.7 percent of the atoms are of the slightly lighter isotope ^{235}U; unlike its more abundant cousin, however, ^{235}U is fissile. Fissile nuclei are the essential ingredient in fuel for nuclear fission reactors. Light-water reactors (LWRs), the most common reactors in use today, cannot run on natural uranium because the ^{235}U concentration is too low. In LWR fuel, the concentration is increased — the uranium "enriched" — to from 2 to 4 percent. Nuclear bombs are made with uranium enriched to much higher levels, typically to 90 percent or more. However, in principle, and usually also in practice, enrichment technologies used to produce LWR fuel can also be used to make nuclear explosives.

Thus, uranium enrichment has played a pivotal role in the development of nuclear energy for both peaceful and military purposes since the last years of World War II. Enrichment plants produced the fissile material for the first nuclear bomb and have since figured prominently in the nuclear weapons programs of each of the five official nuclear powers. At the same time, these facilities have also supplied large quantities of low-enriched uranium fuel, the sine qua non of the rise to dominance of the LWR throughout much of the world.

Today, almost all uranium enrichment takes place in either gaseous diffusion or gas centrifuge plants. The gaseous diffusion process established itself as the most economical enrichment technology at the end of the war and remained so for almost three decades. In recent years, however, advances in ultracentrifuge technology have enabled the gas centrifuge process to challenge gaseous diffusion as the technology of commercial choice. Whether laser isotope separation (LIS) will overtake both processes remains to be seen. Nevertheless, there are increasingly reliable indications that one or more of the laser processes now being developed will be capable of enriching uranium at costs substantially below those of present alternatives.

The economic incentives for LIS development are considerable; the world market for enrichment (outside the Communist areas) is now worth more than $2 billion annually and will continue to expand fairly rapidly over the next decade as LWRs currently under construction enter service. But laser isotope separation methods, like other enrichment technologies, could potentially also be used for the production of highly enriched, "weapons-grade" uranium. Moreover, some people feel that such

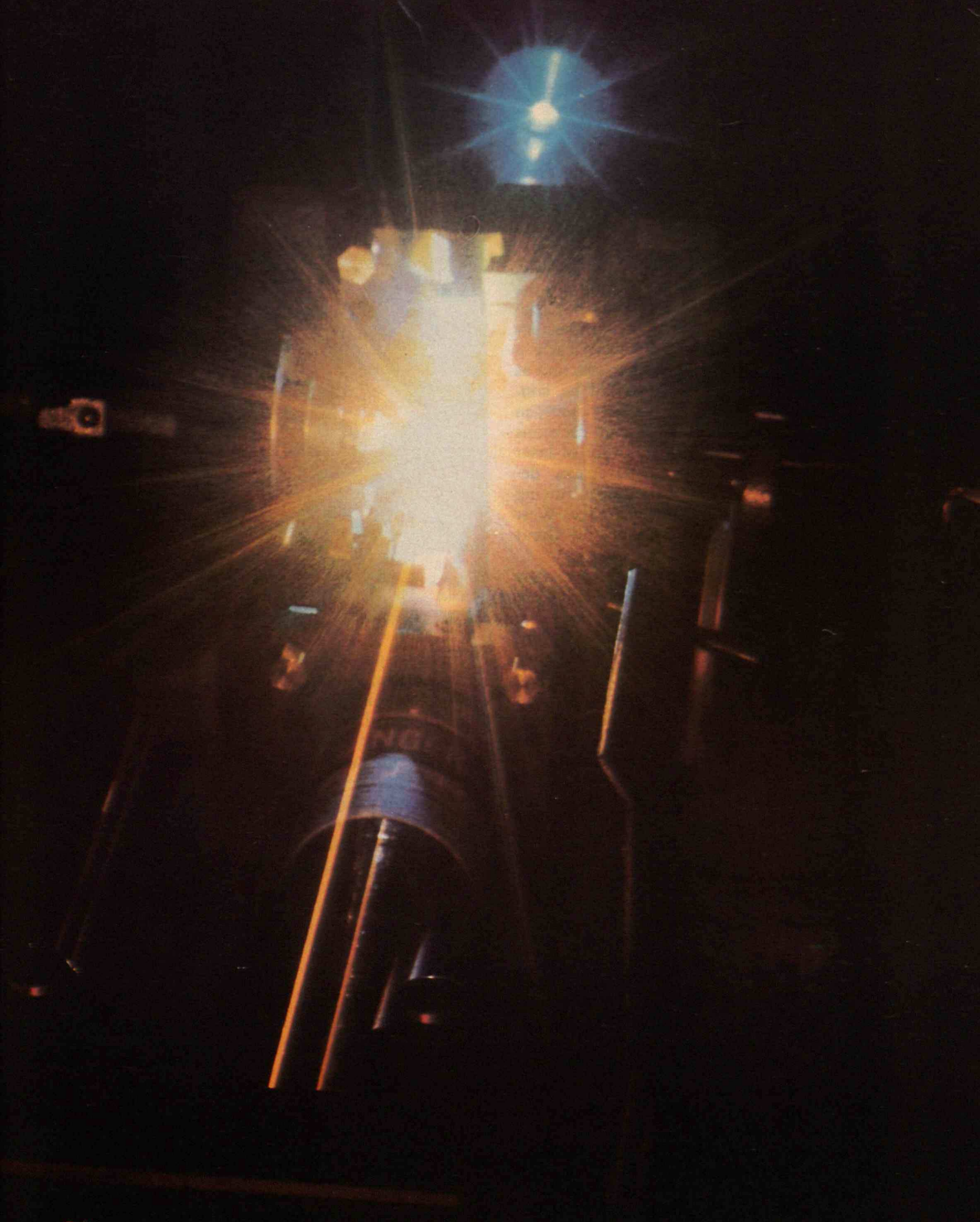
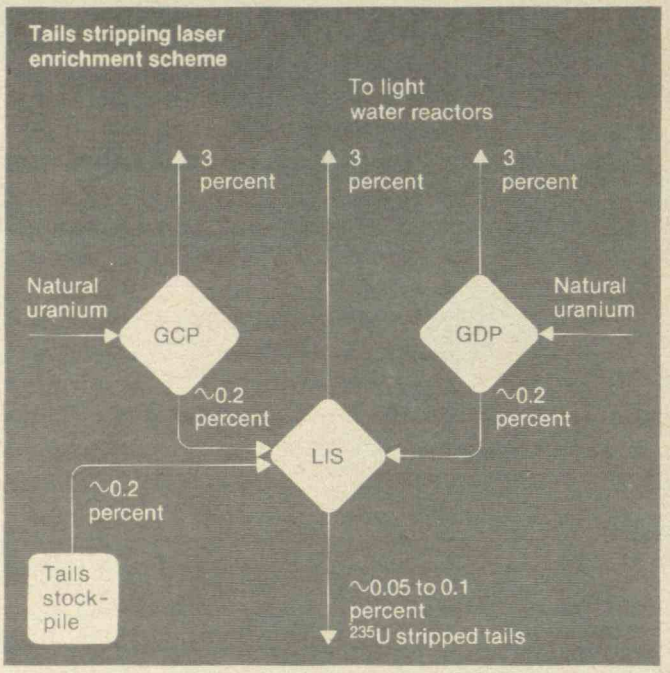


Photo courtesy of Los Alamos Scientific Laboratory

Depleted uranium — "tails" — from both gaseous diffusion plants (GDP) and gas centrifuge plants (GCP) could be enriched by laser isotope separation (LIS) to the 3 percent ^{235}U concentration required for light-water reactor fuel.



methods may eventually provide a simpler, cheaper, and easier-to-conceal route to nuclear weapons than any now available.

Public discussion of these issues has been sketchy, largely because of the inaccessibility of information. For security and proprietary reasons, LIS development programs have been surrounded by secrecy since their inception. However, there is clearly a need for a careful assessment of these issues, and as much of the analysis as possible should be conducted in the public domain, particularly since, in the United States, important investment decisions with profound implications for the future of laser enrichment will be made shortly. Overseas, development of laser enrichment technology is moving ahead in several countries, including France, West Germany, the Soviet Union, Australia, and Great Britain.

Despite their potential significance, the decisions pending in this country are on a small-enough scale — in terms of budget and short-range effects — that they could be made with a minimum of public debate. That would be a mistake, however. The history of nuclear energy development in the U.S. is replete with examples of costly decisions made behind closed doors. Sometimes these decisions — made with the best of intentions — have proved to be wrong and in retrospect would have benefited from a more open debate. In other cases, even when mistakes were not made, the nature of the decision-making process led to a lack of confidence in the outcome and a mistrust of the process. Both these reactions have had crippling effects on subsequent efforts to implement the decisions on a large scale — efforts which, in the United States, require a broad political consensus to succeed.

Laser Enrichment: A Brief Description

Almost all laser-enrichment processes rely on the "isotope shift" effect, the fact that in both molecular and simple atomic states, each isotope of an element absorbs light at its own characteristic set of frequencies. Using this principle, it is possible to excite only one of the isotopes in a mixture by exposing the mixture to light of a precise frequency. The excited species may then be made to enter into chemical reactions or to respond to physical stimuli while the unexcited species remain relatively inert.

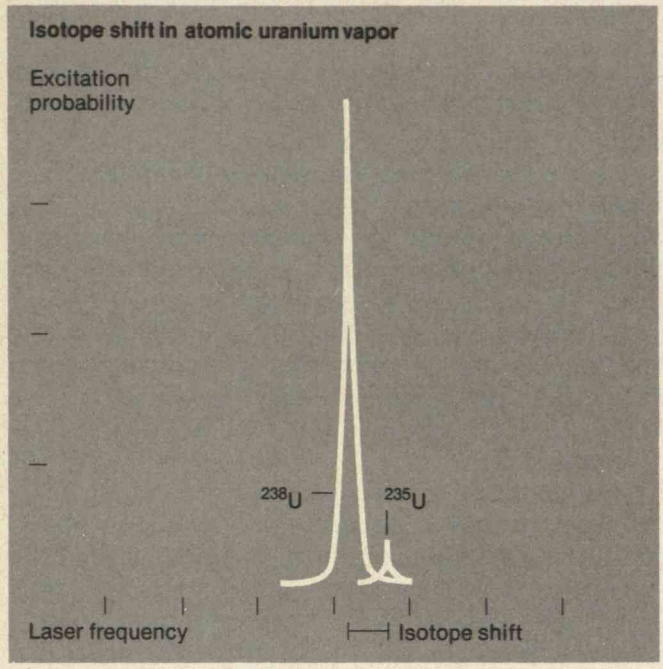
The possibility that isotope separation could be achieved by such photophysical or photochemical means was recognized early this century. But it was not until the invention of the laser some 20 years ago that industrial applications of this technique began to show promise. Because of their ability to provide short bursts of very high intensity, precisely tuned monochromatic light over a wide spectral range, lasers are ideally suited for photophysical and photochemical isotopic separation processes.

The first investigation of laser isotope separation methods for uranium enrichment was launched jointly by Exxon Nuclear Corp. and the Avco Corp. in early 1971. Soon the two formed a joint subsidiary, Jersey Nuclear Avco Isotopes (JNAI), to develop the process further. From the outset, the group concentrated on an atomic vapor laser isotope separation approach (AVLIS). ^{235}U atoms in a high-temperature uranium vapor stream are preferentially excited by laser photons. These atoms are further excited and ultimately ionized by the absorption of additional laser photons, and then deflected onto collector plates by external electric and magnetic fields. The un-ionized atoms, depleted in ^{235}U, pass through these fields undeflected.

Federally funded LIS research and development began a year later at Los Alamos Scientific Laboratory (LASL) and a second federal program was initiated in 1973 at Lawrence Livermore Laboratory. The latter group also opted for an AVLIS approach. But at Los Alamos, a molecular scheme (MLIS) was chosen.

The target material for the MLIS was uranium

Different isotopes of the same element absorb light at slightly different frequencies. This difference, shown here for ^{238}U and ^{235}U, is called the isotope shift and provides the basis for most laser enrichment schemes. The dramatic difference in peak heights reflects the relative abundance of the two isotopes in natural uranium.



hexafluoride (UF_6), which is volatile at room temperature and pressure. Unfortunately, at room temperature the overlap between adjacent energy levels in the UF_6 spectrum obscures the isotope shift effect. Yet at lower temperatures, where the isotope shift *is* resolvable, the UF_6 vapor pressure is far too low to be useful for a commercial process.

The LASL investigators overcame this problem by expanding the UF_6 through a supersonic nozzle. On passing through the nozzle, the vapor is cooled to a very low temperature, at which the isotope shift is resolvable but the density of the gas — in a supersaturated nonequilibrium state — is still relatively high. The $^{235}UF_6$ molecules can be selectively excited by irradiating the supercooled gas at the nozzle exit. Actual separation can then be accomplished by several alternative means.

The auguries were good for the MLIS and both the AVLIS programs. The Los Alamos cooling nozzle was hailed as a breakthrough, and there were early predictions that large-scale enrichment capability was imminent. (The hailing and predicting were both quite discreet, however, since the LASL program was strictly classified.) Also, both the Exxon-Avco and Livermore groups reported early success with small-scale atomic uranium isotope separations.

Since then, progress has been steady, if not as rapid as had been expected at first. According to a statement by the Exxon-Avco group late in 1979, there are no fundamental obstacles to the eventual large-scale application of the technology, although difficult engineering problems remain. At that time it was estimated that large-scale production could begin by about 1990. Recent government plans call for commercialization of one of its advanced isotope separation technologies by the mid-1990s. (Since 1977, the government has also been funding the development of a "laserless" advanced enrichment technique by TRW, Inc. The two laser processes and the TRW process constitute the government's advanced isotope separation program.)

Comparing Technologies

Despite much optimism, none of these technologies has yet been demonstrated to be economically feasible. However, there are increasing indications that LIS processes will be capable of enriching uranium at costs substantially less than any method presently in use. Like the gas centrifuge process, both AVLIS and MLIS will probably require, per unit of output, less than 10 percent of the energy consumed by the gaseous diffusion process. And laser enrichment capital costs are expected to be significantly lower than those of either gaseous diffusion or gas centrifuge facilities.

Underlying all comparisons of laser enrichment with conventional enrichment processes is one central fact: in an LIS process, natural uranium can be enriched to reactor-grade uranium in a single step, or at most a very few. By contrast, in both the gaseous diffusion and gas centrifuge processes, the amount of separation achieved at each step, or "stage," is very low. In both cases, many stages (diffusers or centrifuges) must be connected in series (a "cascade") to enrich natural uranium to 3 percent ^{235}U.

The high degrees of separation per stage achieved by laser enrichment processes should enable them to recover a higher percentage of the valuable ^{235}U isotope from natural uranium than is economically feasible in conventional diffusion or centrifuge enrichment plants. When producing 3 percent enriched uranium, such plants typically discharge about a quarter of the original ^{235}U in a depleted waste (or "tails") stream. The amount of ^{235}U discharged in the tails is determined by a trade-off between the two primary factors in the cost of enriched fuel: the cost of natural uranium and the cost of enrichment. By reducing the amount of ^{235}U in the tails, more "separative work" and less natural uranium are required to produce each ton of enriched product. At

current enrichment and natural uranium costs, this trade-off results in enriched uranium that is cheapest when the tails contain about 0.2 percent ^{235}U. At this tails concentration, almost a quarter of the ^{235}U originally present in the natural uranium "feed" is wasted.

In one possible operating scheme, laser enrichment plants of either type could re-enrich the tails discharged by conventional plants to a ^{235}U concentration of 3 percent. About 75 percent of the otherwise wasted ^{235}U in the conventional tails could be recovered by this means; in the process, the conventional tails could be "stripped" to a ^{235}U content of about 0.05 percent. Laser enrichment facilities deployed in this "tails stripping" configuration would reduce the amount of natural uranium required to produce one ton of 3 percent enriched fuel by almost 20 percent. The energy potential of available uranium supplies would effectively be extended by a similar amount.

Influence Through Leadership

We turn now to the policy issues raised by laser enrichment technologies and ask first whether, indeed, large-scale development in this country should continue.

There are two possible reasons for terminating or postponing current programs: poor economics, and the likelihood that the technologies will have an adverse effect on international security. At present, the economics are highly promising. The total cost of developing one of these technologies to the point of commercialization is expected to be less than $1 billion. Cost estimates for AVLIS and MLIS facilities are consistently at least 50 percent below current costs. If this projected cost differential materializes, then the development expenditures could be recouped in the form of fuel cost savings after about four years of operation of the current U.S. LWR population. Of course, it is possible that laser enrichment costs have been substantially underestimated, or that the future world demand for enrichment services will be so low that the investment would not be recoverable. For the moment, however, even with the precipitous decline in projections of nuclear power growth, continued investment in LIS development appears to be on sound economic ground.

Several potentially adverse impacts of laser enrichment technologies on international security are possible. As we shall see, the arguments pro and con have a familiar ring; similar issues figured in the controversy surrounding President Carter's 1977 decision to defer domestic nuclear fuel reprocessing indefinitely:

☐ Continued development of laser enrichment could result in a process that would be much easier to adapt to the production of weapons-grade uranium than any enrichment method now available. Moreover, the U.S. program could stimulate parallel development efforts overseas and thus unleash a particularly dangerous and unmanageable technological genie. And finally, even if the outcome is not a radically simpler way of producing highly enriched uranium, the U.S. would nevertheless have encouraged the addition of a new path to nuclear weapons.

☐ Continued U.S. development could result in an attractive process with economies of scale favorable for the construction of small commercial facilities (with a capacity for serving, say, a few 1,000 Mwe LWRs). The spread of such facilities to other nations would inevitably increase the risk of misuse. Yet adding a new, economically attractive, "appropriate" enrichment process to the list of sensitive technologies that the U.S. currently withholds from international trade, while enjoying their benefits itself, would tend to aggravate already strained nuclear relations between the U.S. and other nations. Only if U.S. laser enrichment development were halted, it might be argued, could this dilemma be avoided. Moreover, by stopping now, when the commercial prospects are potentially attractive but unproven, the signal would be ambiguous: did development cease because it was commercially infeasible or because it was dangerous on nonproliferation grounds? This ambiguity might cause others to hesitate: for those interested mostly in the commercial applications, the prospect would appear less inviting; and for those more interested in the military potential but seeking to conceal it under a cloak of civilian aspirations, the camouflage might seem flimsier.

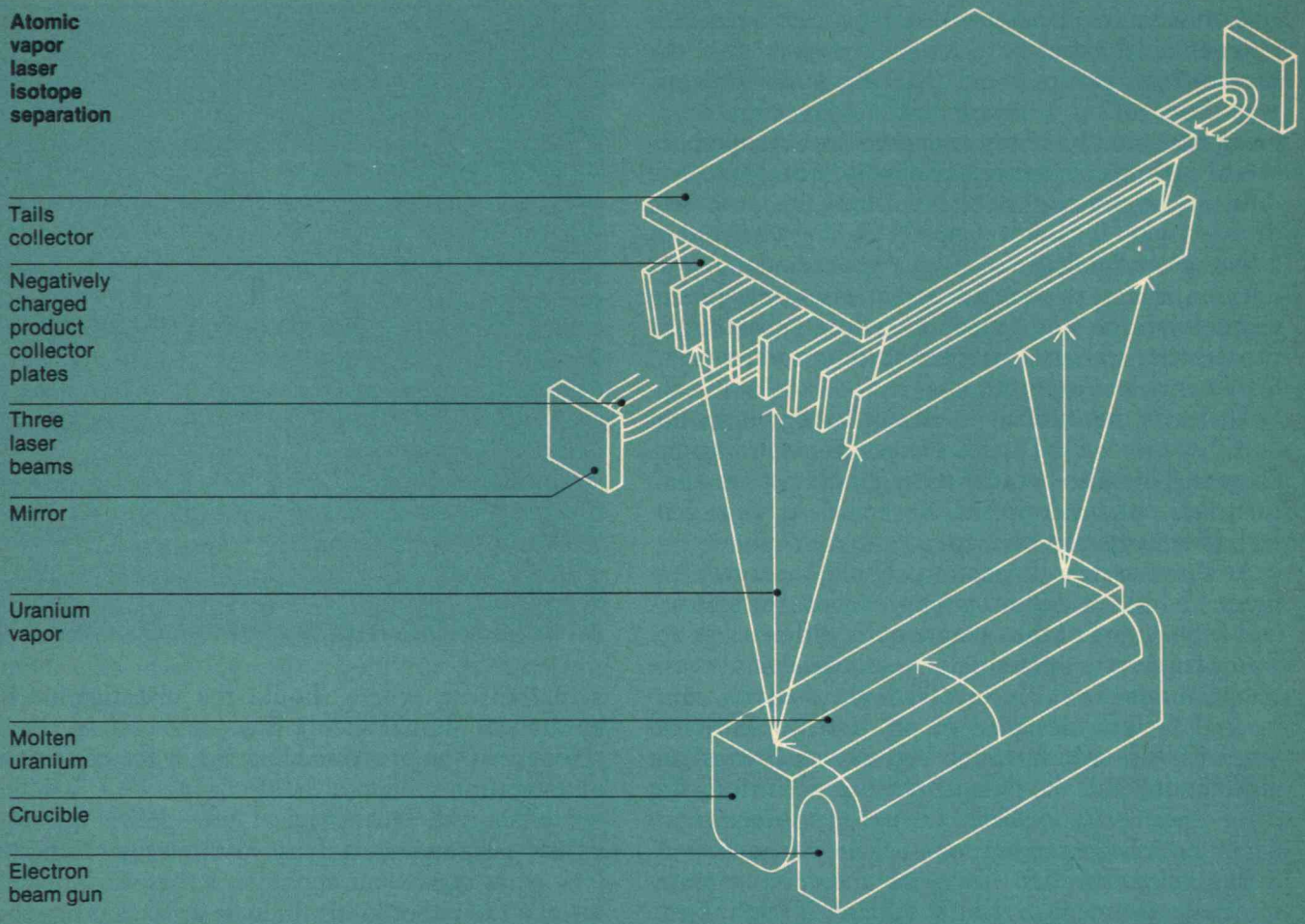
☐ Finally, continued aggressive U.S. development of LIS processes could undermine parallel U.S. initiatives to prevent the international spread of other "sensitive" nuclear technologies such as fuel reprocessing.

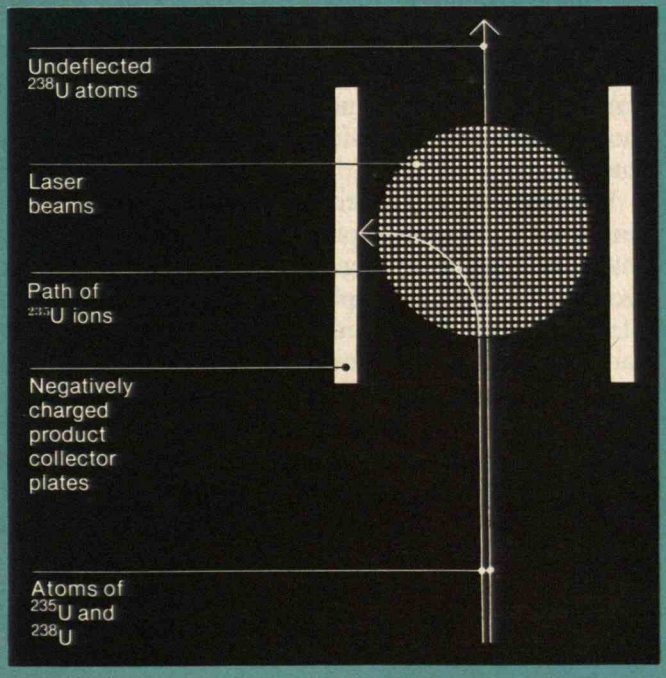
Taken together, do these arguments provide a convincing rationale for slowing or stopping current U.S. laser enrichment programs?

In early references to the proliferation potential of laser isotope separation, vivid images of "garage technologies" and a "cottage industry" for prolif-

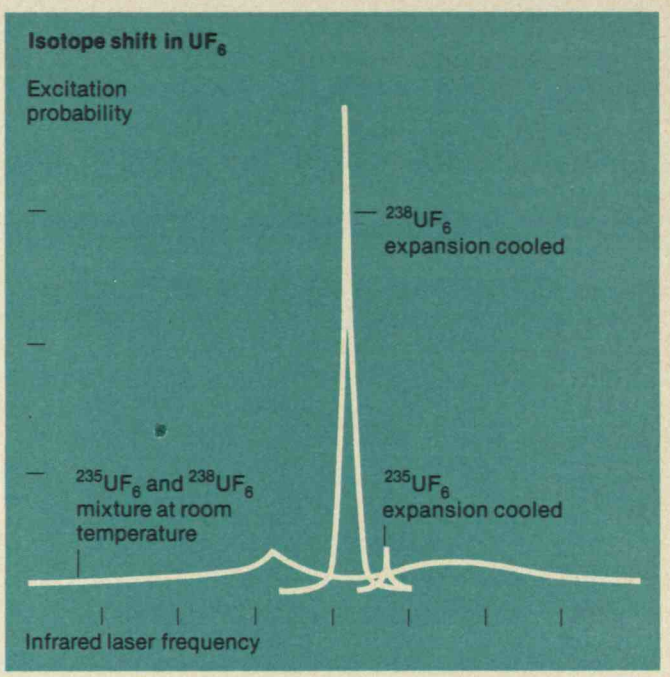
In one type of atomic vapor laser isotope separation scheme, molten uranium is vaporized by an incident electron beam and subjected to three brief laser pulses. The first two pulses selectively excite the ^{235}U atoms. The third pulse ionizes these excited atoms, which are then deflected onto charged collector plates. The un-ionized ^{238}U atoms are undisturbed by the electric field and accumulate on the tails collector plate.

Atomic vapor laser isotope separation





Molecular laser enrichment is carried out with uranium hexafluoride (UF_6). At room temperature, the infrared absorption bands of $^{235}UF_6$ and $^{238}UF_6$ overlap and the isotope shift cannot be detected. However, at lower temperatures achievable with an expansion nozzle, the absorption bands are narrower, the isotope shift is detectable, and the $^{235}UF_6$ can be selectively excited.



eration were frequently evoked. However, a panel of independent experts recently convened by the Exxon-Avco group found that the AVLIS process, "far from being a simple technology capable of being mastered by many countries and even subnational groups, is extraordinarily complex and difficult. Its practical application remains at least a decade away. It cannot properly be characterized as a 'garage technology.'" And a government report released this year concluded that laser enrichment technologies do not appear to reduce substantially the existing technical barriers to the production of highly enriched uranium.

The facts are difficult to establish, of course, not only because of the strict secrecy surrounding LIS programs but also because the technologies are at an early stage of development. Nevertheless, some general statements can be made.

At the outset, a distinction should be drawn between the AVLIS and MLIS approaches: the physics and engineering of the two are quite different, as are their proliferation potentials. Also, two distinct proliferation scenarios are involved: the use of a commercial facility, designed to produce low-enriched uranium for LWR fuel, for high-enriched uranium production; and the independent construction of a plant specifically dedicated to the production of highly enriched uranium for nuclear weapons.

Regarding the first scenario, there is currently some disagreement over how difficult it might be to convert a commercial laser enrichment plant of either type to the production of highly enriched uranium (HEU). In contrast, the behavior of centrifuge cascades at high enrichment is well understood and quite predictable, and the conversion of a commercial centrifuge plant to HEU production is generally acknowledged to be a straightforward task.

Underlying the controversy about laser enrichment is technological uncertainty about the behavior of such plants under the different conditions required for producing highly enriched uranium. Indeed, the uncertainties associated with the conversion of commercial LIS plants could themselves constitute an important deterrent to a would-be proliferator. On the other hand, when a process with good commercial prospects also has potential military applications, there is an obvious need to assess the significance of the latter before widespread commercial deployment occurs. This suggests an interesting dilemma: if there is a value to the preservation of the uncertainty, and also in knowing the actual threat, where should the investigative line be drawn? Should such a decision be left to the developers of the process? How might the costs of the investigation influence the decision?

Neither the technological nor policy questions have clear answers, at least at this stage. Nevertheless, what does seem apparent is that a commercial LIS plant of either kind would be at least as hard and probably harder to adapt to HEU production than a centrifuge plant. (Gaseous diffusion plants are also hard to misuse; however, to date only nuclear weapons powers have built such plants, and economic factors make it increasingly unlikely that any more commercial diffusion plants will be built in the future.)

With regard to the dedicated facility scenario, the single most persuasive piece of evidence that neither AVLIS nor MLIS are "garage" technologies is not technical at all. It is simply that, despite the existence of three large, independent programs in the U.S., each established for several years and employing over 100 people, an LIS plant capable of producing enriched uranium on even a small scale does not yet exist. Furthermore, all three groups estimate that several more years and an overall cost of several hundred million dollars will be necessary before commercial feasibility can be demonstrated.

But these figures, while impressive testimony to the difficulties involved, do not tell the whole story. There are important differences between a program

whose objective is to develop a technology to a level at which it can operate successfully in a highly competitive commercial environment and one oriented less toward reliability and economic performance than toward the quickest, cheapest production of highly enriched uranium.

A good example is provided by the gas centrifuge process itself. It has taken the U.S. two decades and at least several hundred million dollars to develop this highly advanced, apparently economically competitive technology, and the large plant that the government is to build at Portsmouth, Ohio, as the next increment of U.S. commercial enrichment capacity, will cost several billion dollars. On the other hand, construction of a small centrifuge facility, annually producing enough HEU for a few bombs and using relatively unsophisticated equipment, might be completed by a country with only modest industrial capabilities within a few years and at a cost of less than $100 million. Pakistan presently seems intent on demonstrating the accuracy of this scenario. Similar considerations also hold for reprocessing technology.

Nevertheless, even with the relaxation of the constraints imposed by commercial competition, the technical difficulties are still likely to be severe, particularly for the AVLIS approach. Successful development of any AVLIS process will require the integration of several complex technological systems and methods, including a highly advanced laser system and associated optics, a very sophisticated uranium evaporation system, metal vapor handling systems, highly corrosion-resistant optical surfaces, and plasma extraction technology. Even if major advances bring one of these technologies within reach, mastery of the others and a complicated system integration would still be necessary. In sum, it is hard to imagine a set of circumstances in which a state would perceive the construction of a dedicated atomic vapor laser enrichment facility as an easier route to obtaining nuclear weapons material than alternatives such as centrifuge enrichment or chemical reprocessing of irradiated nuclear fuels.

In the case of molecular LIS, the outstanding technical problem appears to be the development of suitable infrared and, especially, ultraviolet lasers. While the other necessary skills and components are not "shelf" items, they would probably lie within the capabilities of nations below the first tier of technological and industrial development. Thus, unlike the AVLIS process, the "proliferation resistance" of MLIS seems likely to depend largely on the extent to which suitable laser systems, if and when they are developed, remain inaccessible. In the long run, therefore, potential proliferators may perceive an MLIS approach to be significantly less challenging than an atomic vapor process. Of course, the future discovery of a new laser system/uranium material combination could radically alter all these conclusions.

A comparative "proliferation resistance" assessment of this kind, however, can only aid the formulation of policy, not substitute for it. Most important, it does not address the political dimensions of the problem — for example, the extent to which other countries would be influenced by domestic U.S. laser enrichment policy. There is no doubt that large-scale development of LIS technologies in the U.S. will provide both justifications and incentives for similar programs in other countries. But the impact of a unilateral U.S. decision to cease development on security grounds is much less clear-cut. Other countries with growing LIS programs have economic and political incentives to develop advanced enrichment technologies regardless of American actions. To the extent that development is fueled by international competition, the withdrawal of the leading competitor (which the United States now appears to be) might temporarily dampen the fires. But the other incentives to proceed would remain; the vacuum would be filled in time, and a new leader would emerge. The process would continue, but without U.S. leadership. The ability of the United States to influence international arrangements for the control of the new technologies would have declined as a result.

As noted, many of these arguments are reminiscent of the earlier debate over reprocessing. But the political implications of enrichment and reprocessing technologies to the United States are quite different. Unlike reprocessing, commercial and technological leadership in enrichment has always been a central element of U.S. nuclear policy. The huge gaseous diffusion plants originally built for military purposes enabled the U.S. to guarantee supplies of enriched uranium fuel under attractive conditions and at low prices — a crucial factor in the rise to dominance of the light-water reactor in the U.S. and overseas. The sales of reactors and fuel that resulted brought substantial economic benefits to the American nuclear industry. In addition, through controls attached to nuclear exports, the government was able to guide the course of foreign nuclear energy programs in directions consistent with its

goal of preventing the spread of nuclear weapons.

In recent years, as concern over proliferation has intensified, enrichment capabilities and supplies have assumed even greater significance for American policy. Since late 1976, a key objective has been to delay the onset of commercial reprocessing and the widespread distribution of plutonium in the civilian nuclear fuel cycle. Recognizing that a principal incentive for reprocessing is concern over access to supplies of low-enriched uranium for LWRs, the U.S. has argued that supplies of uranium will in fact be adequate to sustain the current 'once-through' fuel cycle for a longer period than originally envisaged. Steps have also been taken to reassure other nations of U.S. reliability as a supplier of enrichment services. At the same time, the U.S. government continues its longstanding policy of applying controls and conditions to its enrichment exports; indeed, recent legislation (the Nuclear Non-Proliferation Act of 1978) requires the government to extend the scope of its nonproliferation controls to increase its leverage over the nuclear power programs of those countries it supplies.

Many people doubt that the present legislative package will achieve its desired effect. But no one would dispute that the ability of the U.S. to influence the course of events in the international nuclear fuel cycle is very closely tied to its position in the international enrichment market. International competition for enrichment sales has intensified: the Soviet Union and two European consortia have already entered the market, others plan to follow, and there will be surplus enrichment capacity at least until the early 1990s as a result of the slowdown in nuclear power programs throughout the world. As competition grows, an enrichment supplier's position will be determined more than ever by the price it offers. Therefore, a decision by the U.S. to abandon its leading role in the development of the next generation of enrichment technology would be both inconsistent with the fundamental tenets of its international nuclear policies and an unfortunate and dramatic reaffirmation of the shift in the balance of nuclear influence away from the U.S.

Furthermore, aside from the political and diplomatic advantages that the laser enrichment technologies might bring to the U.S., and the disadvantages that might follow from their abandonment, the uranium conservation potential of laser enrichment adds weight to the argument that uranium supplies will be plentiful enough to delay the need for reprocessing, plutonium recycling, and fast breeder reactors. To be sure, the 15 to 20 percent extension provided by tails stripping will not be enough to sway those in the opposite camp; after all, estimates of proven uranium reserves are reported to within an error margin of 20 percent, and an LIS-derived increment of 20 percent pales beside the much larger uncertainties associated with estimates of undiscovered "potential" resources — the focus of the present uranium supply controversy. Nevertheless, commercial tails stripping, in conjunction with other measures to increase the uranium consumption efficiency of the present once-through fuel cycle, could reduce current LWR uranium requirements by as much as 40 percent. While long-term concerns over uranium availability will remain, pressures on uranium supplies in the near term could be eased considerably.

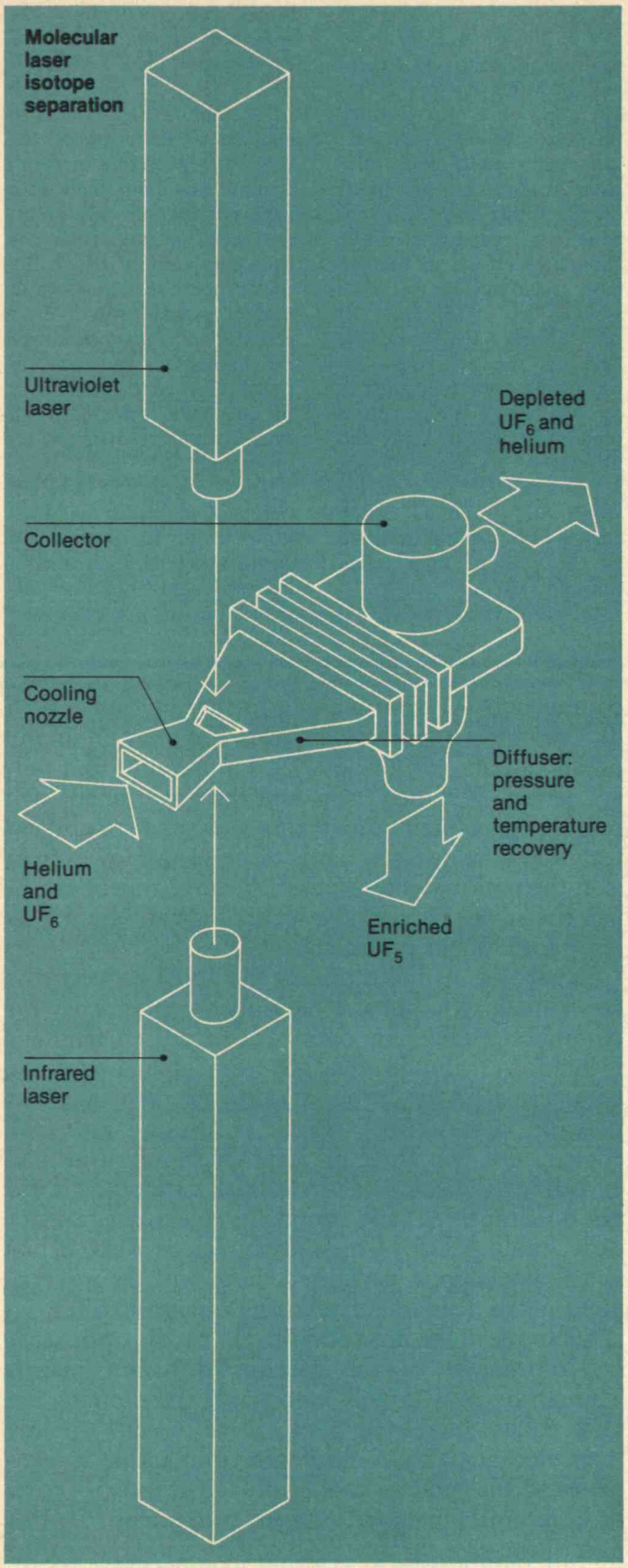
On balance, despite residual technical uncertainties concerning proliferation resistance, U.S. nonproliferation interests would not now be served by a decision to abandon or defer current laser enrichment development activities. The potential benefits of such a step seem marginal at best, and while it is possible that little would be lost as a result, it is more likely that an important opportunity to influence the future evolution of the international nuclear fuel supply system would be foregone.

Competing or Complementary Technologies?

Continued development of laser enrichment technology raises a quite different set of questions regarding the organization of the U.S. enrichment industry, for which there is no parallel in the reprocessing debate. In particular, it raises the possibility of an early obsolescence for the proposed new gas centrifuge plant at Portsmouth, Ohio.

The original timetable for the Portsmouth plant, announced by the Carter administration in early 1977, involved a modular construction program, with the first of four increments entering service in 1986 and full operation beginning two years later. Shortly after this announcement, any possibility of technological competition between the gas centrifuge plant and the new laser enrichment technologies was effectively preempted by the government's decision to concentrate henceforth on developing a "tails stripping" laser enrichment process. (JNAI followed suit soon after.) A tails-stripping laser facility would complement the gas centrifuge plant (and the existing gaseous diffusion facilities) rather than substitute for it.

In one molecular laser enrichment scheme, a mixture of helium and UF_6 is expanded through a cooling nozzle, where it is irradiated with both infrared and ultraviolet light. The infrared laser selectively excites the $^{235}UF_6$. The ultraviolet laser then disassociates the excited molecules into uranium pentafluoride ($^{235}UF_5$) and fluorine. The desired $^{235}UF_5$ precipitates out as a white powder.



This decision seemed reasonable at the time. Although there is no technical reason why laser technologies could not enrich natural uranium, there was no chance that any of the advanced separation technologies would be ready for commercialization by 1986, and the new Portsmouth centrifuge plant would postpone the need for additional conventional enrichment capacity until the mid-1990s. Moreover, there is already a large tails stockpile equivalent to almost 110,000 tons of naturally occurring uranium oxide if upgraded in a tails-stripping plant, and roughly as much again will be produced by conventional enrichment operations during the 1980s. For comparison, proven reserves of natural uranium oxide in the U.S. stand at about 650,000 tons. Tails stripping was thus clearly the first commercial target for the new technologies.

Since 1977, however, growth projections for nuclear power in the U.S. and overseas have fallen rapidly, and enrichment demand forecasts have slipped correspondingly. As a result, the timetable for the Portsmouth centrifuge plant has been delayed; the first module is now due to enter operation by 1988, and present plans call for completion of the entire plant sometime in the 1990s, perhaps by 1993. Moreover, further delays are possible, even likely. Therefore, there is now a definite possibility that one or more of the advanced enrichment processes will be in a position to compete directly with at least the later modules of the Portsmouth plant.

The outcome of such competition is impossible to predict at this stage. Comparisons are complicated by the widely disparate states of development: centrifuge technology is on the verge of commercialization, but none of its alternatives has even been demonstrated on a pilot scale. Also, while preliminary estimates suggest a savings of at least 50 percent from the laser processes, centrifuge proponents argue that substantial cost reductions will be achieved in later generations of that technology.

A purely commercial strategy might be to reduce the technological uncertainties by deferring commitment to the gas centrifuge plant for as long as possible, perhaps increasing production at the (currently underutilized) gaseous diffusion plants to compensate. There would be attendant political costs, however. In particular, further delays in the centrifuge project could exacerbate the already seriously eroded image of the U.S. as a reliable supplier of enrichment services, at a time when restoration of this image is considered essential to the success of U.S. nonproliferation policy. Moreover,

delays and the associated loss of continuity and momentum could inflict irreparable damage on the efficiency of the Portsmouth project and cause substantial cost increases. Of course, the counterdanger, that the centrifuge project will be a victim of institutional determinism, is also a concern: inflexibility born of political and bureaucratic inertia could prevent adjustments needed in light of slower nuclear growth.

Considering both the economic and political dimensions of the problem, an intermediate strategy seems necessary. The present commitment to the first module of the Portsmouth centrifuge plant (which represents 25 percent of its total capacity) should be reaffirmed, on something like the present schedule, but a premature commitment to the remainder of the plant should be avoided. At the same time, the advanced isotope separation program should be reoriented to give higher priority to the development of a process, or processes, capable of competing directly with the centrifuge technology. Finally, there continues to be an important role for the advanced technologies as tails strippers, and this application should be vigorously pursued.

Outstanding Issues

After four years at a virtually constant level of funding, the administration has apparently decided in recent months to accelerate development of the advanced isotope separation technologies, proposing to increase program funding by more than 50 percent. In a separate development, JNAI recently decided to discontinue funding of its AVLIS program, and has proposed instead to share its technology with the government if the latter would provide the funds for further development and demonstration. This JNAI action again brings to the fore discussion of the appropriate role for private industry in the U.S. uranium enrichment program. (Nuclear waste management and enrichment are the only stages in the civil nuclear fuel cycle still performed in government-owned facilities.)

Some of the urgency was removed from this issue in late 1976, after several years of sometimes intense debate, when Congress instructed the administration to take responsibility for building the next increment of enrichment capacity. Beyond its commitment to the Portsmouth plant, however, the government still has no clear policy toward private participation in future commercial enrichment facilities. It was primarily this lack of a clear policy that discouraged JNAI from making further investments in its enrichment process. In this case, as in many others, an absence of policy is tantamount to a policy action. Whether JNAI and the government will reach agreement on terms for the proposed technology transfer remains to be seen. However, it is in the national interest that the government establish the strongest possible technological base for its laser enrichment programs.

Regardless of the future of the JNAI process, the government has not yet developed a plan even for commercializing its *own* advanced enrichment technology. Should the government manage the commercialization process with the assistance of private contractors, as it is doing with the Portsmouth centrifuge project? Or should it instead encourage the entry of private risk capital (as it did not do with JNAI) and confine its role to the transfer of technology *out* of the public sector? Also, if private ownership is permitted, how will the government make available its existing tails stockpile?

Such questions are complicated by the approaching retirement of the gaseous diffusion plants. Though by now largely amortized, these plants are nevertheless increasingly expensive to run. Already their electricity costs alone are comparable to estimates of the total — capital plus operating — costs of laser enrichment. Moreover, retirement of all or part of the gaseous diffusion complex in favor of the

Delaying the "Crossover" with Innovation

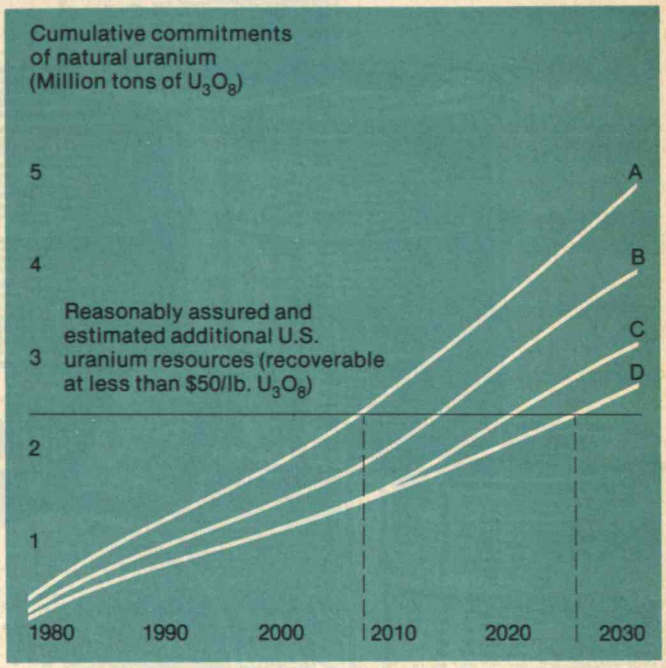
Most of the world's supply of nuclear electricity is presently generated in light-water reactors (LWRs) operating on a once-through fuel cycle. Such systems are inherently inefficient consumers of uranium, and limits on the future availability of uranium resources have stimulated efforts to develop more frugal nuclear fuel-cycle sytems. To date, most of these efforts have focused on "closing" the fuel cycle — reprocessing LWR fuel and recycling the recovered plutonium, first to LWRs and ultimately to fast breeder reactors capable of extracting some 50 times as much energy from natural uranium as the present LWR once-through system.

In recent years the United States, concerned about the risks of nuclear weapons proliferation, has led an effort to delay the introduction of plutonium fuel cycles. In support of its position, the U.S. has argued that uranium is more abundant than once believed; that, in any event, the need for plutonium has been considerably delayed by the dramatic scaling-down of nuclear power growth projections; and that technological innovations can substantially improve the efficiency of the LWR once-through cycle without resorting to reprocessing.

Tails stripping in laser enrichment plants is one such innovation. Its impact on cumulative U.S. uranium "commitments" for one particular nuclear power growth

scenario is shown in the figure at the right. (Commitments are defined as the number of reactors multiplied by each reactor's requirements for uranium over a 30-year lifetime.) Curve A shows the increase in commitments if the present LWR once-through fuel cycle is continued without innovation. As shown in curve B, stripping tails to a concentration of 0.05 percent ^{235}U would reduce cumulative uranium commitments by about 18 percent. Curve C shows the impact of combining tails stripping with another uranium-conserving measure — increasing the "burn up" of LWR fuel. Finally, in curve D these two contributions are combined with additional savings from introducing more resource-efficient Canadian-type heavy-water reactors, operating on the once-through fuel cycle, into the U.S. after the year 2000.

The impact of these measures is considerable. As the figure shows, the "crossover" date beyond which U.S. uranium commitments exceed "reasonably assured" and "estimated additional" U.S. uranium resources is pushed back some 15 years to 2025. The reduction in annual uranium demand would also be substantial. With tails stripping alone, annual uranium demand in 2010 would decline by 18 percent; with all three measures, the annual savings would amount to 43 percent. — *R.K.L* □



much more energy-efficient gas centrifuge or laser enrichment technologies would release a corresponding fraction of the 7,000 MWe of power currently committed to it. Yet replacing these plants, whose combined capacity is some three times that of the proposed Portsmouth centrifuge facility, could cost much more than $10 billion. Is federal financing appropriate, or even politically feasible? Lengthy technical and institutional lead times put these questions close at hand. Yet at present there are discouragingly few indications that the government is addressing them.

On both economic and political grounds, there are persuasive reasons for proceeding without delay with the strongest possible advanced isotope separation program while simultaneously avoiding a premature commitment to the full Portsmouth centrifuge plant. But many technological and institutional uncertainties remain. Will one of the new technologies indeed prove economically superior to the gas centrifuge process, and if so, how long will such a demonstration take? When should the existing gaseous diffusion complex be retired? What institutional arrangements are required to accomplish the forthcoming technological transition? And, above all, what will be the future demand for enrichment services?

Managing an enterprise as large and unwieldy as the U.S. enrichment industry in such a fluid and unpredictable environment is no easy matter. Flexibility must be retained, yet without propagating political uncertainty either domestically or overseas. Without an integrated, imaginative, and farsighted approach to enrichment planning, this goal cannot be achieved. There is still a great deal to be done.

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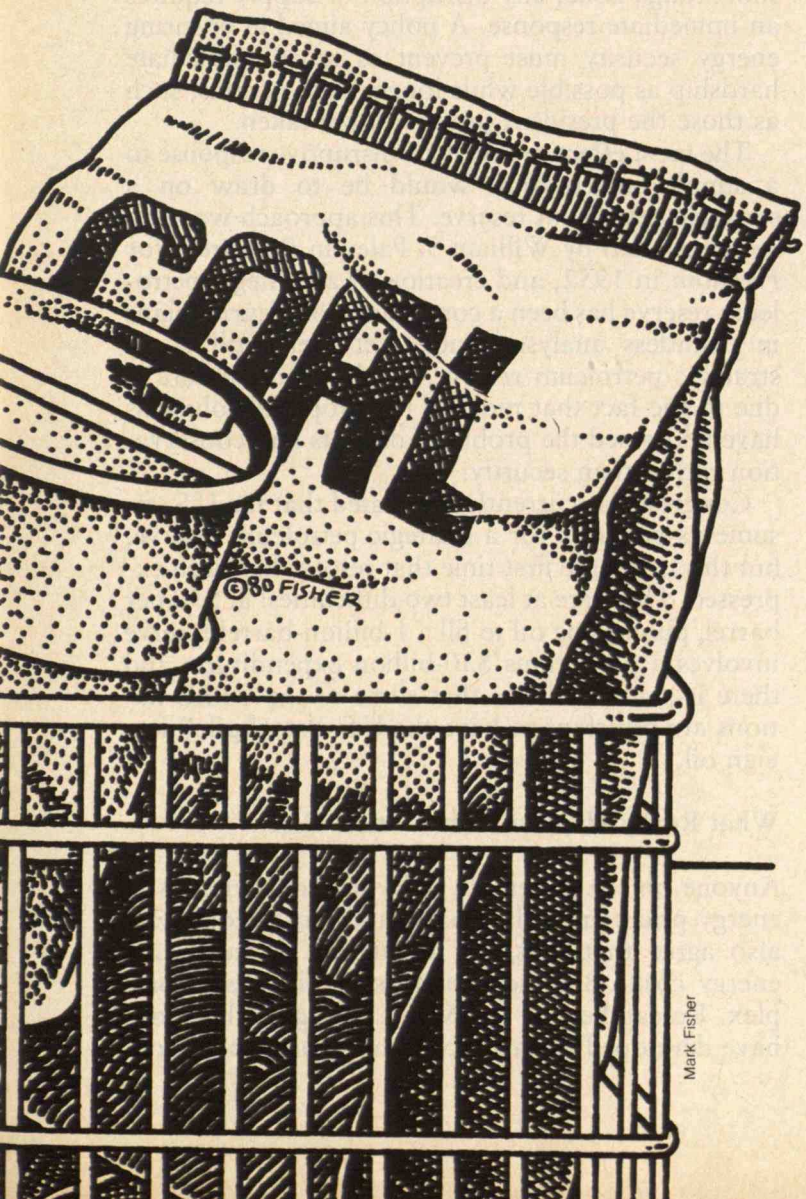
America's shopping list, responsive to security needs and the prices of energy, must include fuel substitutions, conservation, and new technologies to let the resource fit the use.

Energy Choices for the 1980s

by David C. White



Mark Fisher

For at least 100 years prior to the last decade, the U.S. energy industry predicted its future energy needs by extending a straight line through points representing past demand, which grew exponentially. The energy industries then raised capital and built the facilities needed to meet this projected demand. This method worked until the late 1950s and early 1960s, when real costs for the next marginal unit of domestic energy supply stopped decreasing and began to increase.

This basic shift was not communicated to consumers at that time because electricity and natural-gas prices were regulated, and because very large resources of cheap petroleum became available from outside the U.S. These imports appeared to be internationally secure, and the euphoria of the post-World-War-II period still abounded.

The next fundamental change in the energy industry stemmed from the pressure for environmental protection in the late 1960s and early 1970s, when reducing pollutants became a major goal of governmental policy. The easiest way for energy consumers to comply was to use clean-burning fuels — natural gas, middle distillate, and low-sulfur residual oil. Price controls affecting both natural gas and petroleum products were already producing a shortage of natural gas, and they set the stage for future problems in the transportation sector: they encouraged customers to assign a low priority to fuel efficiency in making their marketplace decisions, and automakers to produce automobiles with less-than-socially-optimal fuel efficiency. Stimulated by domestic prices substantially below the true replacement cost of energy, total petroleum demand soared, with low-cost imported crude meeting much of the increased demand. High-cost domestic petroleum resources could not compete.

Thus, the U.S. made itself vulnerable to oil-producing nations, which in the early 1970s initiated the familiar upward spiral of petroleum prices. Unfortunately, the full impact of increased prices has yet to be felt by energy consumers because the government's system of price controls and entitlements continues to tax domestic producers to pay for imported oil. A decontrol strategy is in place, but whether it will be allowed to run its full course is unknown.

Indeed, the energy programs that produced our vulnerability to price increases remain largely in-

tact, protected by a massive bureaucracy. In simplest form, they comprise four elements designed to maintain:

☐ High concern for the environment.

☐ Concern over and if possible moderation of the economic impact on consumers of higher energy prices.

☐ International political independence.

☐ A bureaucracy to address short-term energy deficiencies caused by the above policies, to establish regulatory methods to allocate the resulting energy shortages, and to support research, development, and commercialization of long-term alternatives.

If these continue to be the major components of federal policy, we cannot expect much help from the government in dealing with the energy problem. In fact, with the so-called windfall profits tax and Energy Security Corp. added to the existing programs, one can easily foresee a decade of energy confusion that will make the 1970s look serene.

The Energy Triad: Three Basic Questions

To face its energy problems, the U.S. must deal with three fundamental questions:

☐ How can we ensure the short-term security of our energy supplies?

☐ How can we adjust to increasing energy prices while minimizing inflation and other adverse economic effects?

☐ How can we best stimulate urgent changes in our patterns and technologies of energy consumption to match our available energy sources?

While these questions are clearly interrelated, they should be answered using different basic tools. Unfortunately, these questions and the problems from which they stem are not easily correlated with the four thrusts of our current policy, and our goals and strategies are often very confused in current public debate. For example, policies offered as a solution to a given problem are often relevant only to a different problem, and these mismatches greatly hinder the development of effective national policies.

Only One Cornerstone of Security

Today almost half our petroleum demand is met with imported oil; we import some 8 million barrels a day, and demand is rising. Events of the past year have made it clear that the internal political stability of many of the producing nations is uncertain. Because we are by no means totally dependent on any one such nation, we are not likely to be confronted by a total loss of imports. However, the loss of even 1 or 2 million barrels a day would have significant impact and create major difficulties.

One way to resolve this insecurity is to increase domestic resources, reducing our dependence on imports. The latest of many schemes proposed for this goal is President Carter's program of July 1979 to reduce imports by 50 percent by the end of the 1980s through conservation and increased supplies of heavy crude and synthetic fuels. Security was one of the justifications for this two-phase program, but it is a solution justified by a different problem. Conservation involves changes in end-use efficiency that typically take two to ten years even under conditions of accelerated change. Changing domestic supply patterns — especially constructing synthetic fuel plants — also takes time. In contrast, security is a short-range issue; any disruption of supply requires an immediate response. A policy aimed at ensuring energy security must prevent as much immediate hardship as possible while longer-term actions, such as those the president proposed, are taken.

The most effective and least disruptive response to a supply interruption would be to draw on a strategic petroleum reserve. This approach was first recommended by William S. Paley in *Resources for Freedom* in 1952, and creation of a strategic petroleum reserve has been a cornerstone of security plans in countless analyses since. Yet there still is no strategic petroleum reserve. I believe this failure is due to the fact that most of the proposed solutions have addressed the problems of costs and conservation rather than security.

Congress has currently mandated that the U.S. resume its program for a strategic petroleum reserve, but this is not the first time that resolve has been expressed. There are at least two difficulties: at $30 per barrel, purchasing oil to fill a 1-billion-barrel reserve involves a prodigious $30-billion expenditure; and there is some evidence that some of the OPEC nations are reluctant to have the U.S. "stockpile" foreign oil.

What Really Happens When Prices Rise

Anyone on the street can tell you that increases in energy prices are inflationary, and most people will also agree that jobs are threatened by increasing energy costs. But the dynamics involved are complex. Researchers at the M.I.T. Energy Laboratory have developed a macroeconomic model to explore

Our dependence on imported oil can end if other fuels can replace the liquid fuels now used for nontransportation purposes.

these interrelations; their conclusions are complicated and still incomplete, but the essential facts are these:

☐ A sharp, unexpected increase in energy prices directly causes an amount of inflation that is the product of the ratio of energy costs to gross national product and the fractional increase in all primary energy costs. For example, if energy prices rise 50 percent and primary energy costs are 5 percent of the gross national product, the energy price change is directly responsible for adding 2.5 percentage points to inflation.

☐ For fully anticipated energy price increases, wages and other cost components in a theoretically free-market economy would decline to offset the inflationary surge. However, when the change is unexpected and the economy constrained, this self-correcting mechanism fails to work and the shift is instead aggravated by cost-of-living pay raises and increases in other costs as well.

☐ Since wages and other prices fail to adjust to a new environment in the short run, the price system fails to allocate resources efficiently. Furthermore, the transfer of real income to oil-rich nations makes U.S. consumers poorer. The net result of these forces is a sharp decline in employment, demand, and investment activity.

The researchers are convinced that certain economic policies "normally" taken to stem inflation might actually exacerbate the problems caused by higher energy prices. Tightening the money supply to combat inflation discourages investment activity and thus hurts economic growth. Any government effort to delay or counteract energy price rises distorts the price signals to potential investors and so reduces the incentives for long-term energy conservation. A policy of maintaining energy prices below the true social cost of energy compounds the problem by encouraging energy demand to rise above the economic optimum, making us more vulnerable to the next sharp price change.

There is reason to believe that planned increases in energy costs that encourage long-range energy investments are less inflationary than unexpected price changes to which the economy cannot adjust. Taxes on energy may be attractive for this reason, particularly on fuel for transportation to assure fuel-efficient vehicles. Energy prices should be set closer to marginal costs, including social costs; there should be plans for reduced economic growth rates and government-industry cooperation to increase productivity. Tax incentives for investment and re-

The energy programs that produced our vulnerability to price increases remain largely intact, protected by a massive bureaucracy.

ductions in payroll taxes are attractive alternatives to tightening the money supply because they promote capital formation and may reduce inflation. These measures more accurately describe the energy policies of the developed European nations and Japan than those now in effect in the United States.

An Energy Path to the Year 2000

It is obvious that we must make adjustments in energy production and end-use technology so that our most available energy resources are used more cost-effectively. Unfortunately, while many observers foresaw our present predicament, little or no action was taken during the last two decades. Now we must make a very rapid transition to a new management and use of energy — our capital needs will be almost unprecedented and the likelihood of both technical and social strains is very high. Furthermore, in the U.S. the necessary transitions continue to be impeded by pricing distortions and environmental uncertainty, both of which must be promptly eliminated if our energy resources are to match our energy desires. I believe that a path that is both economically sound and environmentally acceptable can be found.

In discussing the major elements of this transition, I make no attempt to forecast future demand growth; rather, emphasis is on rebalancing current demand to today's resource base. If there is significant growth in energy demand in the future, resources can probably be expanded to meet that new demand.

Here are the priorities we should set for our use of energy resources:

☐ Transportation should have first priority in the use of liquid fuels.

☐ Natural gas should be devoted chiefly to residential and commercial space heating and to industrial specialty use.

☐ Industrial process heat and some electric generation should be provided by coal, with the balance of electric generation coming from uranium and hydro.

☐ Renewable sources (such as solar and biomass) should be used where possible but can be effective only in limited, small-scale applications.

☐ The technology for producing synthetic gaseous and liquid fuels from shale and coal should be brought to a state of readiness by government and industry, but commercial commitments for multiple synthetic fuel plants should be undertaken by industry only and based on market needs without price controls.

These priorities would have developed naturally in a free-market economy. Furthermore, the best way to encourage the necessary transition is through pricing, supplemented by a few carefully structured incentives. Most proposals for changing fuel-use patterns when first-order priorities are not met — that is, when the optimum free-market fuel mix is distorted — are likely to be short-term fixes with little relation to long-term economic choices. For example, while synthetic fuels could fulfill a number of needs today, such short-term needs are not a sound basis on which to build a stable synthetic-fuel industry. Synthetic-fuel plants that we build in the present decade will be serving us well beyond the year 2020. While it is easy to justify synthetic fuels to reduce today's burden of imports, there are other more-economical ways to accomplish the reduction of petroleum imports.

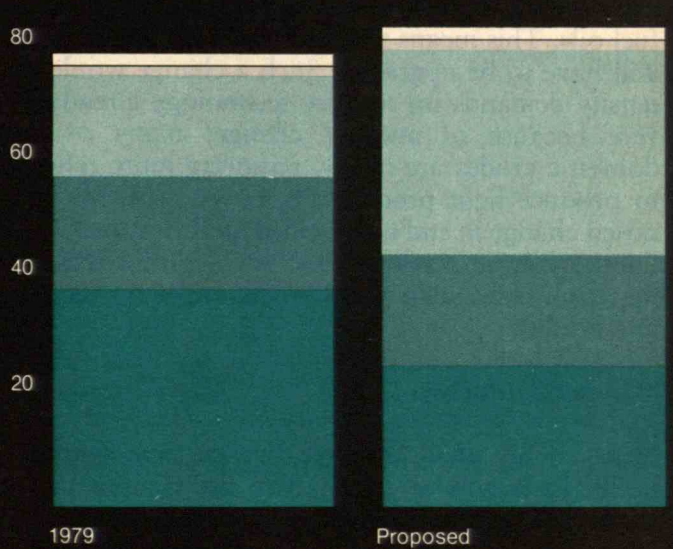
By the early part of the next century, we will sorely need the fuels that a mature synthetic-fuel industry can provide, and we will have clearer insight into what those fuels should be. Major capital investments — some $20 billion or more in this decade — will be needed for programs to build and test synfuel technologies at full scale. Government incentives to develop and prove the necessary new technology — but not to build any commercial-scale plants incorporating it — are therefore needed today. World oil supplies will be barely adequate to give us time for the difficult and expensive process of creating a new industry, even at full steam ahead.

Liquid Fuels for Transportation

Total petroleum consumption in 1978 was 17.5 million barrels per day (bbl/day), of which our transportation sector used over 9 million bbl/day. At the same time, domestic liquid-fuel production was also over 9 million bbl/day, enough to approximately meet transport needs. My judgment is that domestic liquid fossil fuels can continue to meet transport needs throughout the 1980s, with increasing demand for transportation matched by gains in the efficiency of transportation fuel use. Improving transportation efficiency will involve considerable pain for suppliers of transportation equipment and services as well as for consumers. However, we know that 40-to-50-mile-per-gallon automobiles can be built and that similar efficiency gains are

The rational energy strategy for the U.S. should begin with an analysis of needs and resources. The chart shows such an analysis of demand (*top*) and the results in terms of energy resources on which the nation must draw (*bottom*). One quad is 10^{15} Btu's of energy — the energy in roughly 40 million tons of coal. The "proposed" uses are not forecasts; in the author's view, they represent what probably would have happened over the past few years under a free-market economy.

Petroleum-derived liquid fuels should be reserved primarily for the transportation sector, for which domestic petroleum will be adequate given expected increases in efficiency of use. Most natural gas should be devoted to residential and commercial needs and specialty industrial use, for which supplies will also be adequate. The industrial sector should reduce its demands for oil, substituting coal where possible. And oil and natural gas use should be sharply curtailed by the electric power industry, which should turn promptly and heavily to coal and/or uranium. Neither synthetic oil and gas nor renewable energy sources figure significantly in this scenario — the synthetics because the technology is not yet mature enough and too expensive (for direct combustion), and the renewables because they are simply uneconomical except in special, low-volume applications. [Note that "electric generation," in addition to being displayed separately, is included under "residential/commercial" and "industrial."]



possible elsewhere in the transportation sector, and rising liquid-fuel prices will encourage acceptance of these technologies. Theoretically, then, domestic petroleum production can fulfill domestic transportation requirements through the 1980s, and our dependence on imported oil can end if other fuels can replace the liquid fuels now used for nontransportation purposes.

Currently there are three other major uses for liquid fuels. Middle distillates are used for residential and commercial space heating; residual oil is used in utility, industrial, and commercial boilers; and selected lighter fractions are used for petrochemicals. We can envision nonliquid substitutes for the first two: for the smaller-scale uses, liquid fuels can be replaced by natural gas. Also, large-scale utility and industrial facilities can shift to coal, using either direct burning with stack-gas emission controls or on-site gasifiers to produce low- or medium-quality gas, also with appropriate environmental controls. These changes are occurring. Natural gas is beginning to replace oil for space heating because of petroleum price increases; for the same reason, the use of coal is now economical for many large industrial and utility installations. These conversions of existing combustion equipment from oil to coal often pay for themselves in five years or less. For petrochemical uses, petroleum, natural gas, and even coal can supply the necessary feedstocks. This highly sophisticated industry will choose the most economic sources and will, I believe, shift most of its future demand away from petroleum.

If petroleum is used primarily in the transportation sector, the mix of products coming from refineries will have to be changed to emphasize the lighter fractions and reduce to a minimum the heavy fuel oils. This means that more of each barrel of oil will have to be upgraded. Such a change would intensify demands on refinery technology already severe because of another change: many of our domestic crudes are heavy, requiring more refining to produce light products. But even with the proposed change in end use, needed modifications in refineries can be accomplished with current technology for hydrocracking and for coking heavy fuel oils and crudes.

Whither Synfuels?

Most energy analysts agree that in time synthetic liquid fuels will be required in the transportation sector to replace dwindling petroleum resources. Aggressive research, development, and demonstration of synfuels are therefore entirely appropriate. But we should not consider synfuels as a petroleum replacement with similar economics and capable of providing the exact mix of solid, liquid, and gaseous hydrocarbons that we have come to demand with plentiful petroleum. For example, the use of synthetic fuels for direct combustion by utilities and industry does not appear economical, at least with technologies we can foresee.

As we begin developing synfuels, the first question is whether to concentrate on liquid fuels from coal or from shale. Current estimates are that shale oil is cheaper than coal liquids by a factor of 1.5 to 2. Indeed, according to those estimates, shale oil will cost $25 to $30 per barrel, making it competitive with world petroleum and possibly less expensive than upgrading the last 15 to 20 percent of the petroleum in any barrel into a transportation-grade fuel. If these estimates are even roughly correct, our initial production efforts should focus on shale oil; experience and economics will eventually establish the optimum mix of natural petroleum and shale oil for the transportation sector.

Synthetic liquid fuels from coal will also be important. The several techniques for turning coal directly into liquids will not provide us with economical energy in the near future. We should view research, development, and demonstration in this field as an investment toward large-scale projects that will be needed in the more distant future; but we must continue and perhaps expand this work to assure the availability of new technologies and to provide much-needed cost data. Although some production capacity will develop from such research and development, liquid synfuels will not protect us against supply interruptions, at least during the rest of this century. Discussion of synfuel development as a security measure only distracts our attention from developing real security measures such as a strategic petroleum reserve.

The first market in this century for synthetic liquids from coal may be for methanol and similar high-grade products produced by converting coal to a gas (containing carbon monoxide and hydrogen) and catalytically converting this gas to a liquid. Methanol may be one of the few fuels that burns cleanly enough to meet our most stringent environmental requirements, especially in crowded urban areas. Its use would concentrate the pollutants in the conversion processes, where sophisticated industrial processes could control them at some location dis-

The best way to encourage the necessary transition is through pricing, supplemented by a few carefully structured incentives.

tant from the point of final consumption. That is an appealing prospect for many urban dwellers, and — while the product will be more expensive than today's fuels — making such a choice is society's right. However, the choice should be made knowing the true costs and benefits involved.

Natural Gas for the Longer Term

In 1978, natural gas supplied 25 percent of total U.S. fuel demand: 20.3 trillion cubic feet of natural gas were consumed, 19.6 trillion cubic feet of this being domestic supplies. If natural gas is to be used primarily for space heating and specialty uses, utility and industrial markets that now consume at least 3 to 4 trillion cubic feet of natural gas should shift to other fuels. To complement this shift, natural gas must replace some of the liquid fuels now used in the residential and commercial markets. If we improve end-use efficiency, increase our supplies through growing domestic production and imports from Mexico and Canada, and add some synthetic natural gas (SNG), then enough natural gas should be available to meet demand and be economically attractive at current world petroleum prices.

Increases in domestic natural-gas supplies are already in evidence. In the 1970s supplies were decreasing, but the 1978 Natural Gas Act has now loosened the regulatory stranglehold on natural-gas production, and drilling has increased; U.S. natural-gas production could stabilize or even increase during the 1980s. In addition, as natural-gas prices become more realistic — that is, closer to the marginal cost of other high-quality fuels — gas supplies will naturally be directed toward priority uses, and end-use efficiency will be improved through use of better technology.

The current situation is encouraging for the development of a long-term, viable synthetic natural-gas industry: a distribution system is already in place (especially important in urban areas); and there is potential for significantly improved end-use efficiencies. The technology for producing synthetic natural gas from coal in mine-mouth plants using above-ground gasifiers is well known, and there is good promise for in-situ gasification. The cost is between $6 and $9 per million Btu's in 1980 dollars — near the low end of the cost spectrum for clean-burning coal-derived fuels. While this price is high compared with the current price of natural gas, markets for synthetic natural gas may develop in the next two decades in locations requiring very clean combustion, where innovative end-use technology can help offset the higher price. For example, natural gas (including SNG) could be used in urban areas with cogeneration systems to produce both electricity and process steam (1 unit of fuel used in a cogeneration plant can produce the same electricity and heat as 1.5 units of fuel used in separate end-use equipment).

Turning to Coal

In 1979 the U.S. consumed some 770 million tons of coal, of which 525 million tons were used by utilities to generate electricity and 60 million tons were used by industry to produce process steam. While a major portion of utility and some industrial steam needs are now fulfilled by coal, my fuel priority list calls for coal to meet *all* those demands. This will require the construction of new coal-burning plants and the conversion to coal of many boilers now fired with oil or gas, as well as considerable expansion of the coal mining and handling industries.

In developing new electric generating plants, the electric utilities' technical and economic choice today is to burn pulverized coal with full emission controls. But promising new technologies are on the horizon, and coal-burning plants that come on stream near the end of the century may be even more economically attractive. For example, Texaco and the Electric Power Research Institute are developing a coal-gasification process used in a combined-cycle system that will improve efficiency of primary fuel use and alleviate post-combustion stack-gas scrubbers. The Tennessee Valley Authority is building a pilot plant to burn coal in a fluidized bed for electricity generation, and there is advanced development work on pressurized fluidized beds that would increase efficiency; fluidized-bed combustion is promising because it reduces some of the difficult problems of stack-gas emission controls.

Converting to coal and providing adequate emission control for the many generating plants now consuming oil and natural gas are the major problems facing the utility industry today. Some plants on the Atlantic seaboard now fired by oil were originally designed to burn coal. Although the regulatory actions of the 1970s failed to force reconversion of these plants to coal, the doubling of oil prices in 1979 may accomplish that goal. Indeed, reconversion to coal, including the installation of flue-gas desulfurization, now has a payback of less than five years.

Policies offered as a solution to a given energy problem have often been relevant only to a different problem.

A more difficult problem is what to do with existing plants that were never capable of burning coal, including many in the Southwest fired by natural gas. Some oil-fired plants may be converted to use a low-quality synthetic oil; and in some cases retrofitting may permit use of synthetic gas with low or medium heating value. Thus, a limited (and ill-founded) demand for synthetic fuels could develop — ill-founded because in almost every instance a government fuel subsidy would be required for continued economical operation. Subsidies for the utility industry to retire such plants early and replace them with coal-fired facilities would probably be a more cost-effective strategy. For example, a 1,000-megawatt power plant consumes the equivalent of approximately 40,000 bbl/day of oil. The cost of a 1,000-megawatt coal-fired plant is less than the cost of a synthetic oil plant capable of producing that 40,000 bbl/day; and coal-fired technology is a much more thermally efficient way to use coal, the primary fuel.

The problem of replacing oil and gas in the industrial sector is different and does not lend itself to any single fix. A recent analysis by the M.I.T. Energy Laboratory finds that, at today's fuel prices, coal-fired industrial process steam boilers with flue-gas desulfurization or fluidized-bed furnaces produce steam at less cost than oil- or gas-fired boilers. Thus, new installations are likely to be designed to use coal. Large industrial complexes may consider on-site coal gasifiers for new installations or as retrofit measures for existing facilities, but with current natural-gas contracts at prices lower than the cost of low- or medium-Btu gas from coal, they are not likely to take this option. In fact, gasifiers may not be necessary in the near term: because of current exploration at greater depths and offshore, natural gas should remain an economical option through the 1980s and perhaps beyond. The trade-offs for industry among coal-burning boilers, coal gasifiers, large-scale production of synthetic natural gas, and natural gas itself are site-specific, and the choice can probably be left effectively to marketplace pressures on industrial firms seeking to minimize their costs.

The Uncertain Place of Uranium

Uranium used in light-water reactors now provides about 13 percent of the annual primary fuel needs of the electric utility industry. My view is that utilities that have made the investment in reactors to produce electric power are using the most environmentally benign and cost-effective way to produce electricity today. Used in one or more of the advanced reactor systems now being developed, uranium should maintain this superiority into the twenty-first century and perhaps beyond. All other systems — coal, solar, biomass, geothermal, ocean-gradient, and the like — involve economic and social costs greater than those associated with nuclear power. But whether today's political and emotional constraints on nuclear power can be resolved remains unclear.

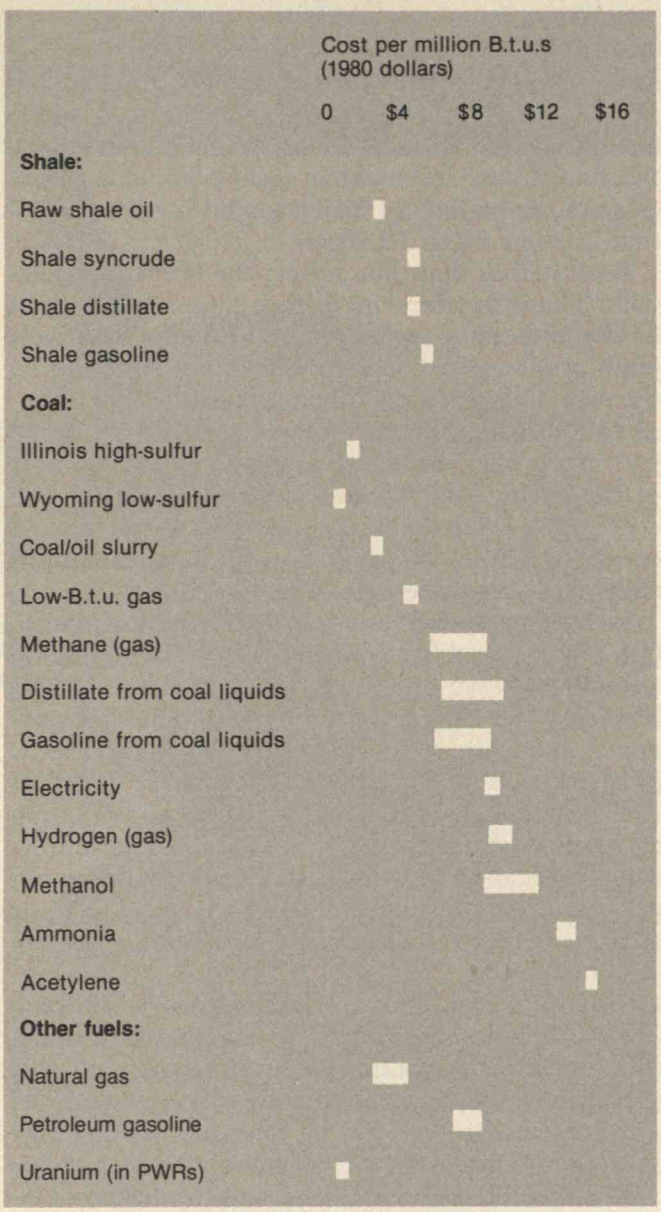
A Hard View of Renewable Resources

About 13 percent of our primary energy today comes from renewable resources, almost all in the form of hydroelectric power. The amount of other renewables now in use is statistically insignificant. Unless there are dramatic changes in either the prices of fossil fuels or the technologies for using renewable fuels, this picture will remain essentially unchanged.

More optimistic predictions abound on the role that solar energy and the other renewables will play in our future, but I put most of them in the category of "forecasting by wishing." Even with massive federal spending and subsidies, the contributions from active solar systems and systems converting biomass to synthetic fuels (such as alcohol) will be small. Such systems are simply not cost-effective with oil at $35 a barrel.

This is not to say that solar energy has been a wholly barren technology. It is true that the systems of active solar panels and heat storage in some of M.I.T.'s solar houses in the late 1930s and 1940s have not yet been improved on; they were not cost-effective then, and they are not — in the New England region — even today. On the other hand, Bell Laboratories' development of the solar cell for direct conversion of sunlight into electricity, based on the electronic properties of semiconductors, remains an extremely promising technology, and there is other new and interesting work on chemical and electronic reactions stimulated by sunlight.

Extensive use of renewables will depend on finding successful new technology, and innovative research on such technology should be a high priority, though I would not like to bet my savings on a solar breakthrough in the 1980s. Like fusion energy, the sun will be too valuable an energy resource to future generations for us to leave its practical utilization to chance inventions from research on some



The cost (in 1980 dollars per million Btu's) of our principal energy alternatives for the last decades of the twentieth century. The chart makes clear the basis for the author's pessimism about the role of synthetics and his reasons for emphasizing efficient use of oil, natural gas, and coal while research and development continue on synthetics and renewable technologies.

All the data presented here, except for "other fuels," are taken from "Alternative Energy Sources for Non-Highway Transportation," ed. by E.N. Carte, Jr., Exxon Research and Engineering Co., 1979. The author estimated the cost of petroleum gasoline based on a price of $32 per barrel of crude.

other process. While such serendipity is often how new concepts emerge, we should encourage many of our brightest minds in a concentrated research effort. Even with such an extensive program, the development of the necessary new technology may be a long time coming — if indeed it can be found.

The Complexities of Conservation

Conservation plays a crucial part in the energy transition of the U.S. and so has an important role in our immediate future. Conservation can come about in two ways: as a rational short- and long-term response to rising energy prices, and as the result of carefully structured regulatory incentives undertaken in lieu of price incentives.

To date, only modest energy conservation has been induced by regulatory systems in the U.S., and none has been achieved without considerable cost. The only action with a large impact has been the mandated automobile efficiency standards; mandated thermostat setbacks have also been somewhat effective. But gasoline allocation without price changes appears to lead more to lines at gasoline stations, often reflecting regional misallocations, than to substantial reductions in consumption. These problems are absent, and consumption is reduced, with rising prices.

Indeed, prices appear to me to be the most efficient tool for encouraging conservation. In late 1979 and early 1980 the price of gasoline doubled, and now we see a 10-percent drop in gasoline consumption. As prices continue to rise, we can expect the same sort of reduction in the consumption of other fuels. Between 1973 and 1979, U.S. energy consumption increased at a compound annual rate of only approximately 1 percent, significantly lower than in the 1960s; and even this modest growth in consumption is unlikely to continue in the 1980s because price-driven conservation will reduce demand. At the same time, increases in energy prices will also constrain economic growth, and — though experts cannot agree on how much — lower economic growth combined with conservation due to high prices will likely assure annual energy growth of less than 1 percent throughout the balance of this century. The social implications of increased energy prices are often cited as a reason to maintain our tradition of artificially low costs. They are not; instead of maintaining low prices for *all* consumers, we should make whatever arrangements are necessary to meet the needs of that minority of consumers

Our energy resources must match our energy desires; a path that is both economically sound and environmentally acceptable can be found.

who are unable to pay the full cost of the energy they need.

As we plan for the future, we need to recognize that there are two types of energy conservation. The first occurs as the result of "tidying up" through more effective management and modest capital investment. Typical examples in industry include stopping unnecessary steam leaks, using heat recuperators, and scheduling heat loads more effectively. Such relatively simple activities enabled the petrochemical industry, for example, to cut its fuel use by 20 to 30 percent after the 1973-74 energy price shocks. In the residential sector, such conservation efforts include reducing thermostats, stopping air leaks, adding storm windows, properly maintaining furnaces, and adding insulation. In the commercial sector, rebalancing heating, ventilating, and air-conditioning systems, reducing lighting levels, and using computers to control heating and lighting loads can be both energy-efficient and cost-effective. Such "tidying-up" activities can yield energy savings of as much as 30 to 50 percent.

The second — and far more important — type of conservation comes through changes in capital stock leading to higher end-use energy efficiency. Some examples include down-sizing and the use of new technologies to improve automobile efficiency, changes in industrial production systems (for example, substituting the Alcoa chloride process for the Hall process to produce aluminum), using gas-or oil-assisted heat pumps for home heating, and using passive solar designs in new building construction (*see "Rediscovering Energy-Conscious Architecture" by Selma A. Newburgh, p. 68*). Such basic changes in industrial processes and capital goods, including residential and commercial structures and equipment, are not accomplished with ease; all require major capital investments in manufacturing, marketing, construction, and industrial processing, and many require additional changes in institutional arrangements in the industrial, commercial, and governmental sectors.

Any conservation activity should emphasize such efforts, yet there are complications. What seems to escape energy theologians who claim that conservation is our cheapest energy source is that this form of conservation stems primarily from capital investment; the actual or perceived saving of energy must result from a shift among the factors of production — energy, material, capital, and labor. Such an optimization of our total industrial sector — more use of capital, less of energy, for example — will require extensive research and development and large capital investments in our competitive society. In addition, different patterns of consumption, including new consumer choices among goods and services, may be involved. Under ideal economic conditions, the time frame for making such major changes is close to the lifetime of major capital investments — that is, some 20 to 30 years.

Even within that time frame, the needed changes will be hard to effect. Increasing conservation is not unlike increasing productivity, and the relatively poor productivity management in the U.S. during the past 30 years gives little optimism for wise conservation management. Changing our consumption patterns is also extremely complex, if only because of the social equity issues involved; differing perceptions of these are already leading to intense and confusing battles in Congress and to confrontations elsewhere across the nation.

Identifying conservation as a painless solution to our energy problems is yet another example of adopting a "man-on-the-moon" technical fix. There is no easy technical fix — not conservation, not solar power, not synfuels. I believe that the tenfold energy price increase we have experienced since 1970, as well as increases yet to come, will force conservation to become a major factor in our energy supply-demand balance. However, unless some wisdom not now apparent prevails, this change is likely to come at the expense of economic growth, and we will all become poorer.

A major transition in our total industrial productivity and consumption pattern is required, and because we have closed our eyes to it for so long, this transition must be accomplished very quickly. Fuel substitutions, conservation, and new technology (including synthetic fuels), all stimulated by a policy of pricing at a level reflecting true marginal costs including social costs, will play important roles in that transition. Its realization with minimal adverse economic impact should be the goal of our national energy policy, and in seeking that goal we must realize that price subsidies and other well-intentioned distortions of true energy costs are distractions that rob Peter to pay Paul.

David C. White is Ford Professor of Engineering at M.I.T. and director of the Institute's Energy Laboratory. Trained in electrical engineering at Stanford, he taught at the University of Florida before coming to Cambridge in 1952 to work in the fields of electric power systems, energy systems analysis, and technology and policy planning. Professor White holds the George Westinghouse Award of the American Society for Engineering Education.

Myth:

Railroads charge too much to move coal.

Fact:

Rail costs are a smaller share of the delivered price of coal today than they were 10 years ago.

The United States has enough coal to break our energy dependence on imported oil. Now, when this vital resource is needed more than ever, America's freight railroads are being accused of charging too much to move coal, thus impeding the nation's shift from oil to coal.

Nothing could be further from the truth. Coal prices and electric utility rates have risen much faster than railroad coal rates. Ten years ago, rail transportation charges averaged 39 percent of the delivered price of coal. Today, they average only 25 percent of the delivered price.

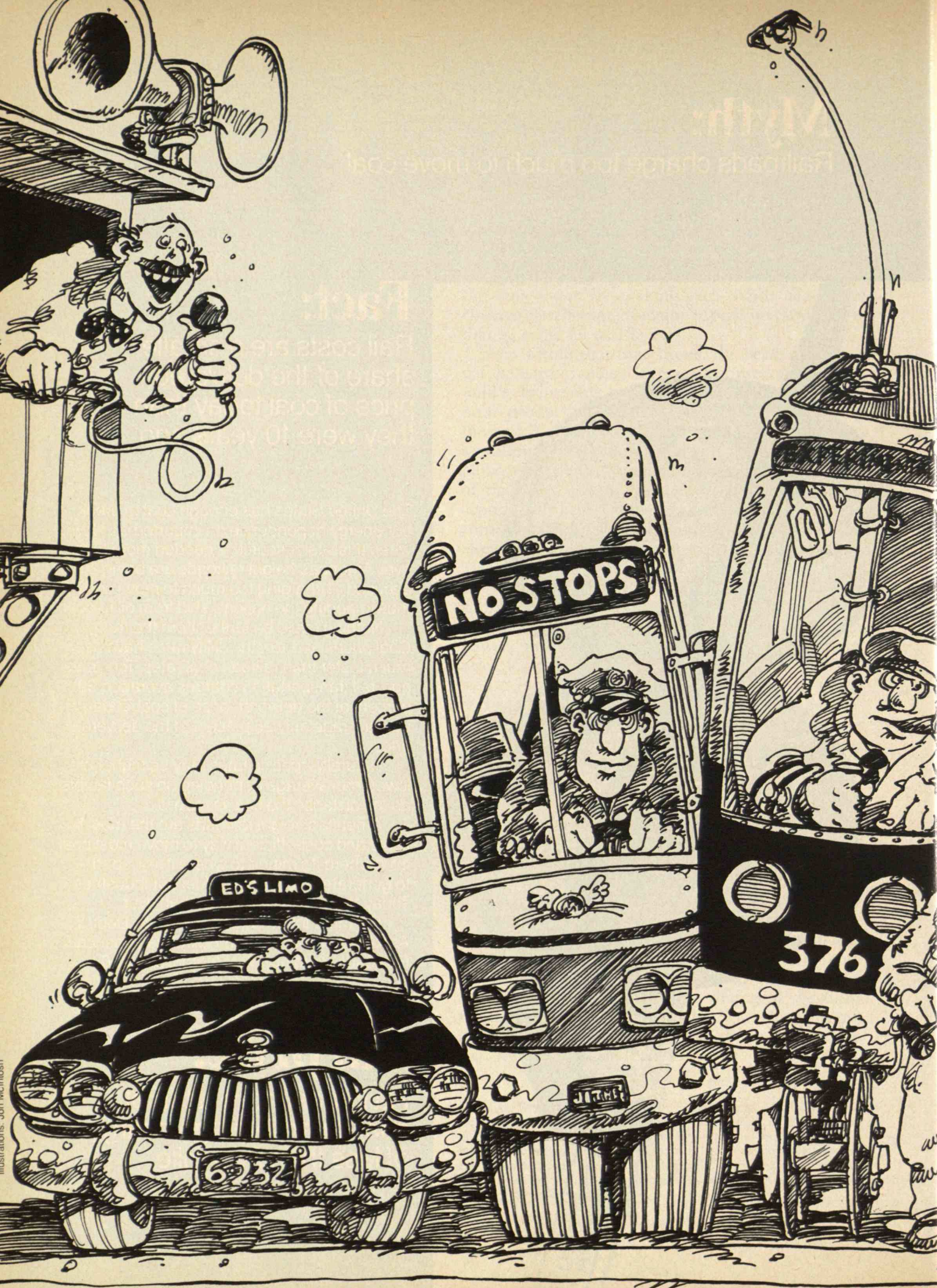
Naturally, specific rates may be higher or lower than average depending on such factors as the distance the coal is moved.

America's freight railroads are the most reliable and cost-efficient way to move most coal from where it's mined to where it's needed—to generate electricity and fuel our industries. Today, that's more important than ever.

For more information, write: Coal, Dept. T, Association of American Railroads, American Railroads Building, Washington, D.C. 20036.

Surprise:

Railroads move a ton of coal for an average charge of less than 2¢ a mile.



Illustrations: Jon McIntosh

Speed Is the Name of the Game

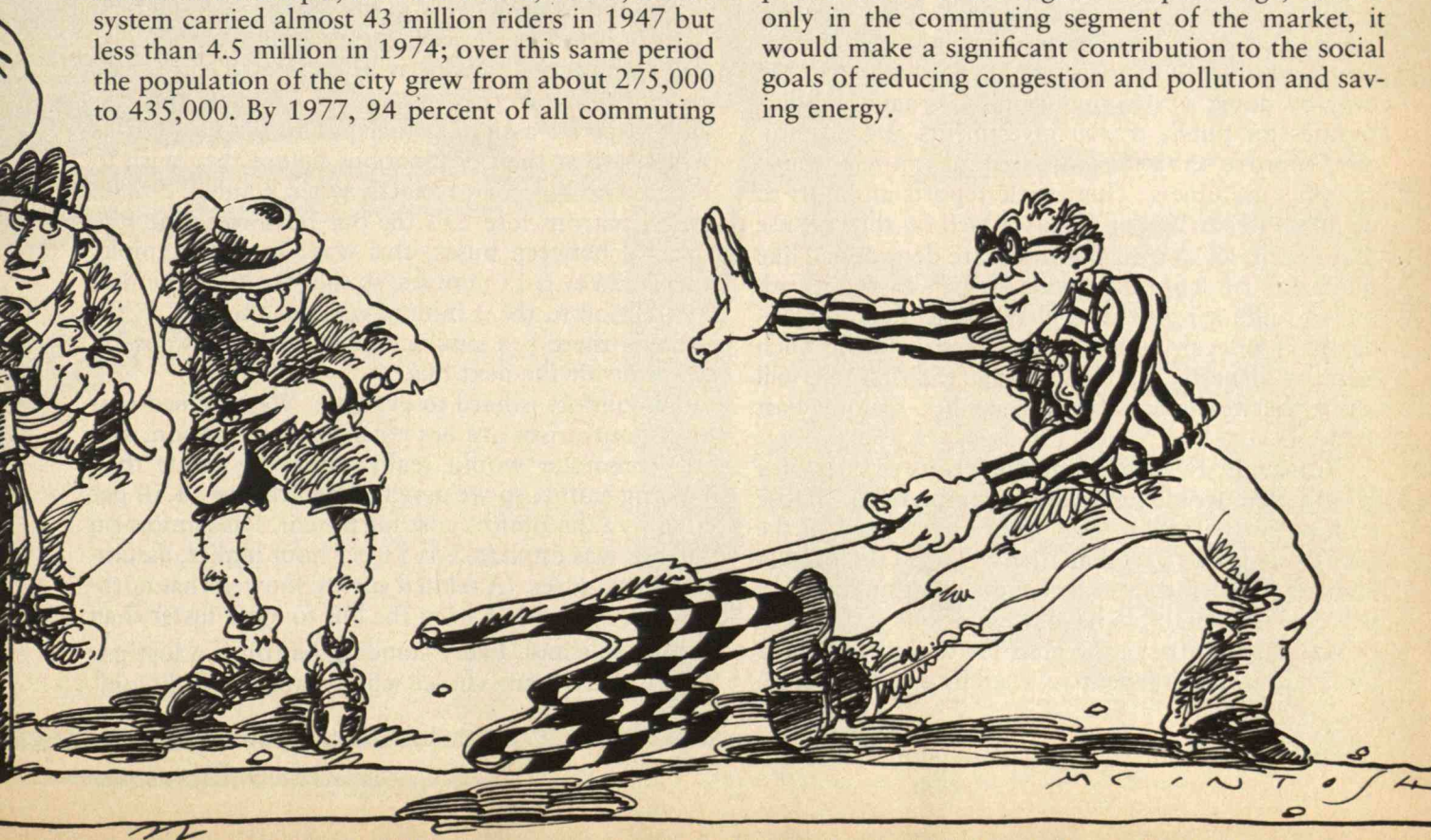
by Jack C. Page

The transportation marketplace works like any other: people choose the goods with the best value. Most urban transit customers value time most highly, and saving it should be a manager's first priority.

For most of the past 30 years, public transportation in the U.S. has been steadily losing patronage to the private automobile. This trend has continued despite massive subsidies to mass transit from federal, state, and local governments and major efforts to persuade the public to use mass transit.

The decline in the use of mass transportation has been very large — larger, perhaps, than most people realize. For example, the Fort Worth, Texas, transit system carried almost 43 million riders in 1947 but less than 4.5 million in 1974; over this same period the population of the city grew from about 275,000 to 435,000. By 1977, 94 percent of all commuting trips between home and the central business district in Fort Worth were by private car (including car pools and "rides with friends"); buses claimed but 6 percent. The downward trend was reversed only once — in 1973-74, when gasoline supplies were curtailed for three months.

Public transit is obviously not meeting the needs of the public as well as the private automobile. If public transit could regain lost patronage, even if only in the commuting segment of the market, it would make a significant contribution to the social goals of reducing congestion and pollution and saving energy.



Speed Heads the Transit Want List

Studies have shown that the public has six basic needs in transportation:

☐ *Speed*. The object is generally to get there as soon as possible, a lesson the airlines have imposed on rail and steamship lines and are now imposing on intercity bus lines.

☐ *Flexibility in time of use*. People want to go when they want to go; they do not like to wait.

☐ *Flexibility in destination*. People want transportation to take them where they want to go, now and at any time in the future. One of mass transit's major difficulties is that people's destination patterns vary greatly except on trips to and from work.

☐ *Comfort*. The automobile does the best job of meeting most people's standards of comfort and privacy.

☐ *Safety*. Almost all standard transportation modes are acceptably safe, but in some instances, public transportation is faulted because of dangers to which users are exposed while traveling to and from it and while waiting for service.

☐ *Low price*. All the above are weighed against a price scale. Helicopters are fine, but cost rules them out for most people. First-class air travel is considerably more comfortable than coach, and at a 25-percent premium it attracts about 10 percent of the market; at a 50-percent premium it attracts almost no one.

While these factors can be postulated qualitatively, it is quite another problem to assign quantitative marketplace values to such intangibles. Yet only by doing so can one weigh alternative opportunities for public transit investments and, eventually, improve service in ways that maximize a transit system's usefulness. This article reports an effort to do that in Fort Worth, Texas, based on the premise that purchases of transportation are determined like purchases of shopping goods — to satisfy a need, not to fulfill a whim. Travelers' choices can be predicted if we can assign a perceived value to each element of need. We assume that each patron will select the mode that for him or her has the best value.

We sought to understand the requirements of a system that would motivate commuters to choose public transportation (bus) over private cars in the rush-hour market. This market is large; the market involves fixed rather than flexible destinations (23 percent of commuters have destinations in the central business district); the need for time flexibility is reduced; and it is repetitive, thereby simplifying research, planning, and communication.

In developing the analysis, the following assumptions were used for representative commuters and their trips:

☐ Commuters' time is valued at $6 per hour. While this number varies widely from individual to individual, it is a median and equivalent to a $12,000-per-year income.

☐ Commuters' trips are six miles each way, average for the city of Fort Worth.

☐ If commuters drive cars, their average speed is 18 miles per hour, while the bus averages 10.4 miles per hour.

☐ Commuters plan to arrive at their home bus stops, a five-minute walk from home, two minutes before the bus is due; the bus delivers them to within less than a block of their destination.

☐ Commuters park their cars a five-minute walk from their downtown destinations.

☐ Comparisons on the basis of safety and other factors are assumed trivial.

Given these assumptions, daily transit time by car for a commuter whose home is six miles from the city center is 0.67 hours (a 12-mile round trip at 18 mph), while transit time by bus is 1.15 hours.

We used this system of analysis, supported by a survey of riders' priorities, to examine the behavior and motivations of riders as described in the following paragraphs.

The commuter's car is in the garage; waiting time is zero. The bus, however, runs only occasionally, and on average patrons will not find the schedule exactly suited to their needs. We calculate this disadvantage by assuming that public transit patrons will arrive at their destinations before they wish to because no bus comes exactly when wanted. On average, patrons lose half the bus headway time (the interval between buses) this way; in our example, the headway is 15 minutes, so the loss is 7.5 minutes in addition to the 2-minute wait for the bus. In the evening there is a similar one-half-headway loss in the wait for the next bus.

Discomfort is hard to evaluate. We assumed that rush-hour drives are not considered recreation, and the commuter would really rather be home than fighting traffic; so we assigned an arbitrary $.50 per hour as a discomfort cost for the car. Discomfort on the bus was estimated as $1 per hour higher, assuming no standees. (A related survey showed that nothing drives a patron from the bus to a car faster than having to stand. Every standing patron is a lost patron if there is any choice whatsoever.) This discom-

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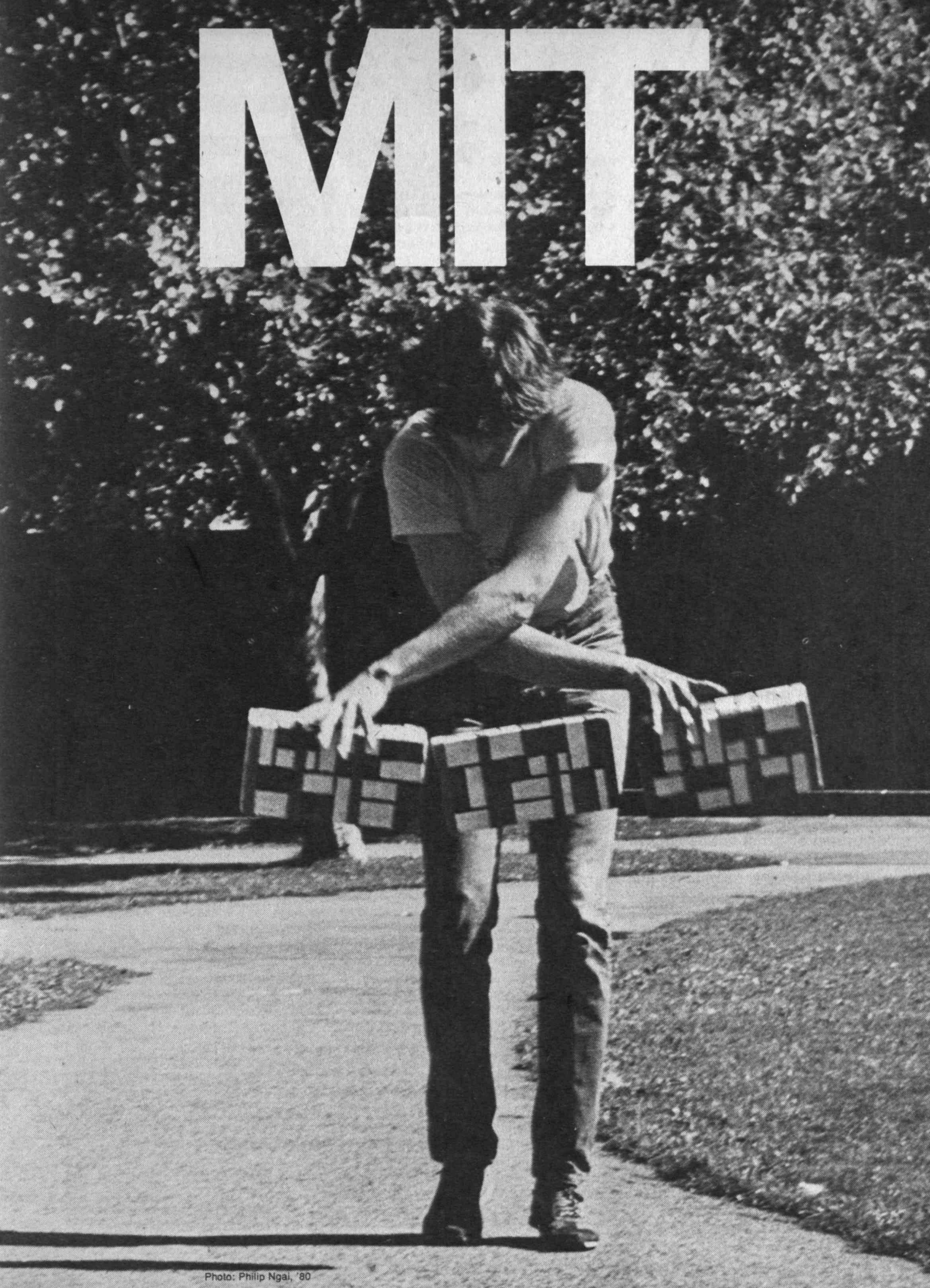
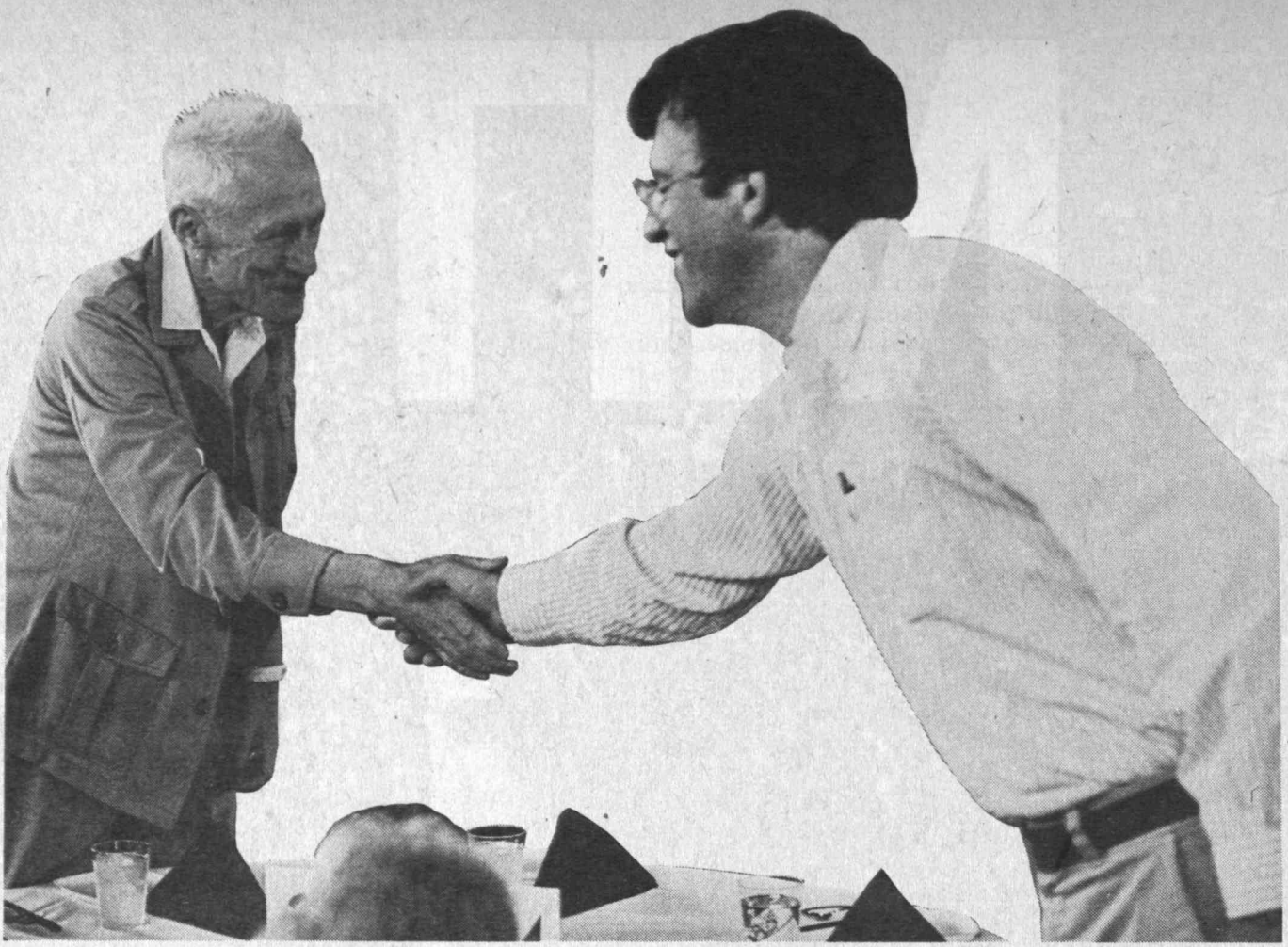


Photo: Philip Ngai, '80



Technology Day: Greeting Old Friends and Pondering National Issues

Almost regardless of what we do to conserve energy and develop new resources, said Mr. Bradshaw, "the U.S. will be more dependent on other nations in the future than in the past. Our real problem," he said, "is how to live in dependence for the next two decades."

While most of the Institute's visitors spent a large part of Technology Day preoccupied with greeting old friends and seeking familiar scenes, they were asked in both morning and afternoon to consider some of the nation's most serious national issues involving technology.

Three of the day's principal speakers stressed the need for more technical manpower — Raymond S. Stata, '57, president of Analog Devices, in his field of information management (see right); Thornton F. Bradshaw, president of Atlantic Richfield Co., in oil exploration; and Professor John M. Deutch, '61, former Under Secretary of the Department of Energy, in energy technology, where there are, he said, "vast research and development needs."

Mr. Bradshaw put the nation's energy problems in stark terms. The U.S. has for all practical purposes abandoned President Jimmy Carter's pledge at the Japanese economic summit of 1979 to limit oil imports to 800 million barrels a day. We simply can't do it, Mr. Bradshaw said, because the rate of depletion of our domestic resources is higher than we expected even a year ago. Indeed, he said, U.S. oil production is on a "down-bound roller coaster."

Almost regardless of what we do to conserve energy and develop new resources, said Mr. Bradshaw, "the U.S. will be more dependent on other nations in the future than in the past. Our real problem," he said, "is how to live in dependence for the next two decades." It is an issue for political and foreign policy as well as for technology — strange bedfellows in an international effort to maintain morality in the face of almost certain energy crises.

From his vantage point of 29 years at M.I.T., Walter Rosenblith, Provost, presented a "retrospective view of the future." "M.I.T.'s evolution into a modern university found in Jerry Wiesner one of its most effective builders and indeed architects," he said.

"In some ways the most profound challenge of technology [is] that it makes possible things for human beings that previously they didn't know were there," said Dr. Rosenblith. To create the atmosphere where this kind of innovation is nurtured, he described a phenomenon that he and Dr. Wiesner shared — an intellectual pressure cooker, called "deep immersion" in a particular subject. That is an educational opportunity that "no other mode provides," he explained.

Awards and Gifts

The formalities of the annual luncheon were as brief as possible and to the point:

Dr. Jerome B. Wiesner holds a book given to him as his retirement approached last June. It holds more than 600 letters written to him by alumni leaders from around the world.

What the Alumni Said to President Wiesner

As the time for President Jerome B. Wiesner's retirement last June approached, nearly 1,000 of the Institute's most active alumni were invited to contribute their personal tributes to a book to be given to Dr. Wiesner on Technology Day. Here are excerpts from a few of more than 600 letters:

"I cannot possibly convey in words the joy and privilege I have always felt in the friendship and common interest in M.I.T. we have shared. It has truly been a blessing in my life."

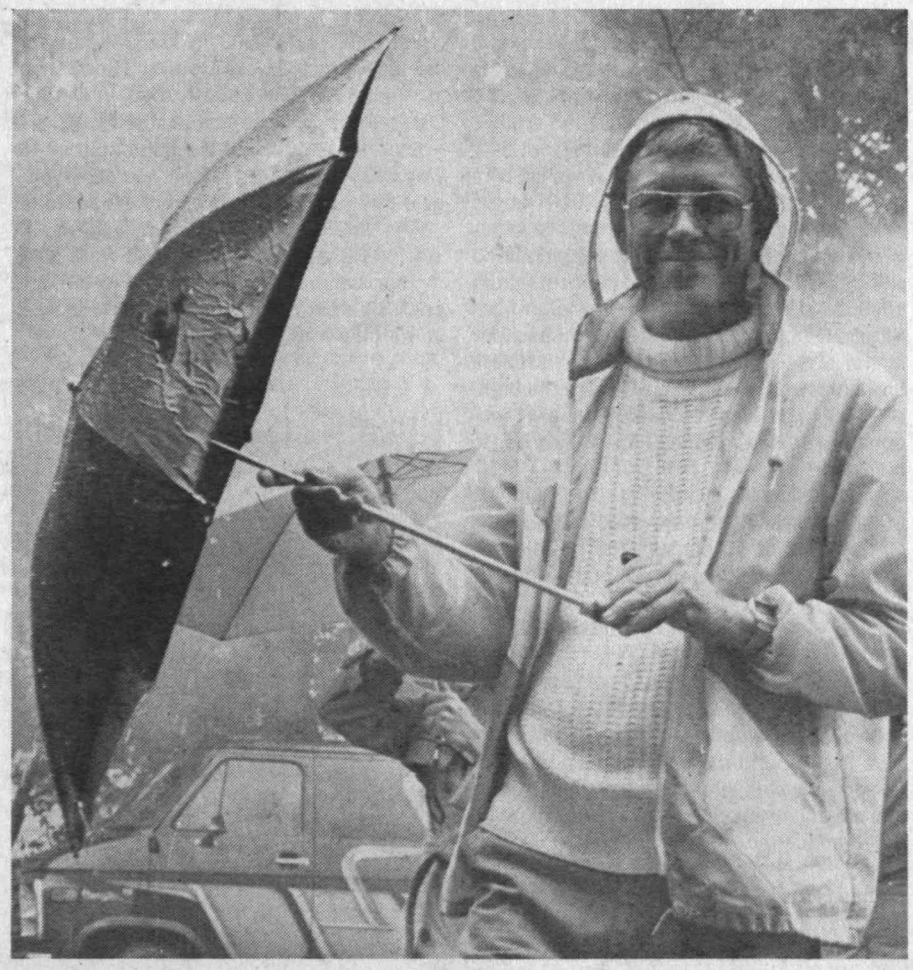
"Most of my get-up-and-go appears to have gotten up and gone, but yours goes on forever. What a wonderful president you have been — admired by faculty, students, alumni, and the world at large."

"Your ability to touch the heart of an individual is a wonder in its own right. Sustaining that ability in the face of pressures and frustrations inherent in the positions you have filled verges on magic."

"The Wiesner years have been punctuated by an unprecedented capital campaign and difficult financial conditions. Despite all the handicaps, no decade at M.I.T. has been more exciting — intellectually and organizationally. Your administration has brought growth in M.I.T.'s quality and stature beyond all expectation."

"A nearly-40-year odyssey brings me to this moment when I reaffirm my earliest impressions — intellectual power, integrity, compelling energy, human compassion, and service without reservation: the qualities which mark a great and good man."

"We all feel proud to have joined you in such a noble endeavor . . . to have shared with you the hope and expectations of a well-integrated approach to learning with excellence as a basic requirement but with the enrichment of the individual as its main objective, the pursuit of advancement of technology to give security and progress to life without abandoning the love of the beautiful . . ."



☐ A standing ovation for John J. Nolan, secretary of the Class of 1903, of Anchorage, Ky., at age 99 the oldest alumnus present; and another for Ching T. Yang, '30, of Shanghai, who had travelled farthest.

☐ Gordon Y. Billard ('24) Awards to Nelson C. Less, '53, director of resource planning who was described as "a key factor in the largest capital campaign in M.I.T. history," and John M. Wynne, S.M.'56, retired vice president — administration and personnel ("clearly one of the best informed and most effective university administrators in the country").

☐ Honorary memberships in the Alumni Association to Ida M. Green, who has collaborated with her husband, Cecil H. Green, '23, in countless philanthropies; Walter L. Milne, special assistant to the president and chairman who has "given selflessly of his personal time" to fulfill his many assignments, including especially M.I.T.'s ambassador to the Cambridge and Boston communities; and Ross H. ("Jim") Smith, retiring as director of athletics, for "his leadership of the M.I.T. brand of athletics."

☐ Class reunion gift presentations totalling nearly $2 million: $781,311 from Ralph W. Peters and Richard M. Wilson for the Class of 1930; $539,090 from Norman R. Klivans for the Class of 1940; $620,000 from R. Peter Toony and Edward C. Ehrlich, Jr., for the Class of 1955; and $1,750 (matched with another $1,750 from the Class of 1930) by Charles F. Irwin from the Class of 1980.

At the Pops: *Arthur Fiedler he's not. And for a while the Tech Night at the Pops audience seemed to be wishing for what can never again be. But then came John Williams' impeccable choice of Ray Jackendoff, Ph.D.'69 (above), to be soloist in Weber's Concertino for Clarinet and Orchestra; his careful management of the orchestra; and the subtleties of their tone and style. Suddenly everyone was saying that the new era might be at least as rewarding in its new way as the old one was.*

Technology Day: an opportunity for old and young alumni to meet. Claude W. Brenner, '47, hands over the gavel of the presidency of the Alumni Association to Harl P. Aldrich, '47 (this page, top).

John J. Nolan, '03, secretary of his class and M.I.T.'s oldest alumnus (at age 99) attending the Technology Day Luncheon, with his son (this page, middle).

Rain didn't dampen spirits for the Class of 1955 at their Clambake at Rivers School (previous page, bottom). (Photos: Gordon R. Haff, '79)

Responding with an expression of his and M.I.T.'s thanks for such support, President Jerome B. Wiesner placed the gifts in "a uniquely American tradition of private philanthropy, based on a realization that we all do better by helping each other."

☐ Presentation to President Wiesner of a volume containing more than 600 letters written to him on the occasion of his retirement by alumni leaders from throughout the world, including all class presidents from 1899 to 1980. One of the letters, from Virgilio Barco, '43, Colombian Ambassador to the U.S., revealed that his government had bestowed its Order of Boyaca, its highest distinction, on President Wiesner in recognition of his "distinguished service to mankind."

☐ Installation by Claude W. Brenner, '47, president of the Alumni Association, of his classmate and successor, Harl P. Aldrich, '47, who assumed the presidency on July 1.

Reunions: Good Fellowship Prevailed

As the organized events of Technology Day gave way to the smaller activities of 13 class reunions, the weather changed from bright blue to gray and then to just plain wet. But good fellowship prevailed and there were successful reunion events everywhere: in the campus houses, at Historical Collections, at the swimming pool, and in the President's House in Cambridge; at the John F. Kennedy Library, Museum of Transportation, New England Aquarium, and "State Street Roof" in Boston; at the stately Corinthian Yacht Club in Marblehead and the less formal Rivers Country Day School in Weston; and at quiet resorts in Dennis, Osterville, and Chatham on the Cape.

Did the rain turn off the good spirits? No way, they said. "Lots of water outside, yes," said one alumnus, "but plenty inside, too."

And when it was all over, no regrets. "It started 29 years ago," she said while waiting for her husband to bring the car and pack their bags, "and this weekend took 25 years off our lives!"

A quiet week-end of nostalgia, good fellowship, and (not too much) serious talking over the problems of the world. A reporter dedicated to hoopla and antics would have come away empty-handed.

The Class of 1950 celebrated at the John F. Kennedy Library (opposite page bottom; this page, bottom left); Class of 1955 picture (top); Explanation of a gift to M.I.T. from China. (Photos, pages A4-A5: Gordon R. Haff, '79)

A "Critical Shortfall" of Technical People: Could M.I.T. Do More?

The "information revolution" is beginning literally to change our lives, extending man's senses and capabilities beyond any reasonable forecast made even as little as two decades ago.

But technology may not be keeping pace.

There is now a "critical shortage" of engineers, managers, and technicians to keep the revolution moving forward, Raymond S. Stata, '57, president and chairman of Analog Devices, told a Technology Day audience at M.I.T. on June 6. More than 30 percent of the work force in the new "knowledge industries" are college-trained, and future progress depends on an "unprecedented supply" of such people.

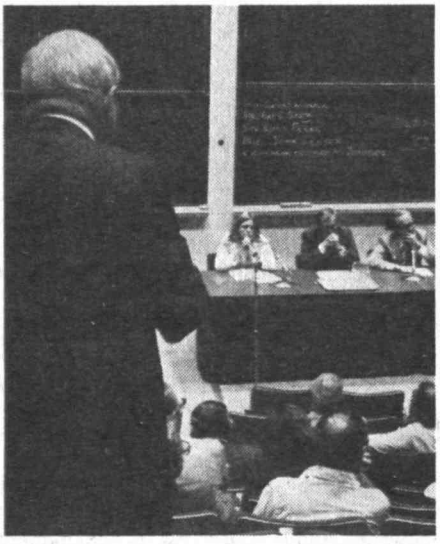
But it's not happening, Mr. Stata complained. The rate at which colleges and universities are turning out people prepared for work in the knowledge industries is "essentially flat," unchanged over much of the past decade. The result: "In every company I know," said Mr. Stata, "good ideas are lying fallow because there are no people to exploit them."

Then Mr. Stata made explicit his challenge to M.I.T.: he has "serious questions" about the growth policies of the Institute and of schools like it; he wants M.I.T. to "take the lead in meeting this new national need. Industrial development should play a larger role in M.I.T.'s policymaking in the future than it has in the past," he said.

It was a challenge for which then President-Designate Paul E. Gray, '54, was not unprepared. From a microphone in the audience he spoke eloquently of the "enormous capital demand" associated with the kind of expansion Mr. Stata sought. There would be expensive new buildings, more students for each of whom the financial shortfall between tuition and costs would have to be underwritten, and expensive new faculty (and the problems that confront Mr. Stata and his industrial colleagues also confront universities when they seek to recruit teachers, Dr. Gray reminded his audience).

Already, said Dr. Gray, New England's colleges are doing more than their share for New England industry. M.I.T., for example, sends 30 percent of its graduates to Massachusetts jobs, while only 10 percent of its students originally come from the state. "We are a concentrator as well as a creator of engineering talent," he said.

"In every company I know, good ideas are lying fallow because there are no people to exploit them."



A friendly confrontation: Paul E. Gray, '54, then president-designate of the Institute, told Raymond S. Stata, '57, that increasing New England's resources of technical manpower is not as easy as it seems.

Margaret Compton: Reminiscences of 50 Years at M.I.T.

Margaret Hutchinson Compton — tiny, sparkling, warm — has devoted her life to M.I.T. for 50 years.

Sitting in her emaculate living room, I listened as she reminisced, asking a question here and there, letting her memory dictate the thoughts that came up.

I asked her about M.I.T.'s evolution during the last half century.

"The impressive thing at M.I.T. is the consistency with which it has moved forward," she answered. She mentions her late husband, Karl Compton, and lights up. "Karl would be greatly gratified if he could see M.I.T. now; it has developed so much in the directions he wanted it to," she said. "Science has become so much a larger part of M.I.T.

"The development of business, economics, public life — oh yes, he would be delighted. When we came to M.I.T. the faculty was all on one level — there were no separate schools. Creatively and administratively, it was a great thing Karl did in establishing separate schools with separate deans. It helped the whole educational program, and bolstered the development of pure science, rather than just the practical.

"One of the stipulations Karl made before he accepted the job as M.I.T.'s president was freedom to build up the Physics Department and build a laboratory for it. He hoped to spend time in the lab himself — but didn't get much chance to. He did what had to be done.

Taken In and Belonging

"I remember so vividly our arrival — it was Saturday morning and Karl had a meeting. I came with the children, and as we came to the front door, the door was thrown open wide, and there was Major Smith (head of buildings and grounds), and lined up on the stairs were all the people we'd be dealing with — four household servants, the electrician, the gardener, all smiling their welcome. We felt taken in and belonging right away.

She told me the story of the house:

"Mrs. McClauren, fragile after her husband's death, worked with Wells Bosworth on the design of the house. He had elaborate plans; but she said no, that she wanted the students to feel like they came into a home. Mrs. McClauren deserves warm credit for the quality of the house.

"I found it a wonderful house to live in. I'm sure it helped set the taste of my children because of its beauty. I moved in with three children, one in high school, one six-year-old, one two-and-one-half. It was so beautiful, with fragile antique furnishing, I wondered how my children would get along. But there was a big room at the top, meant for dances, that became the perfect playroom. I added a trapeze and swing, and a sandbox out on the roof, and that was their play area."

A Great Human Being, and Scientist

"One time at the end of the war, Karl came back from the Pacific where he interviewed Japanese scientists and their reaction to our use of the atomic bomb. We went up to the lake to rest; he got a telephone call from Louis Strauss, who was active with the Atomic Energy Commission. He asked Karl to head the commission, and after he was through talking to Karl he asked me for support. I said I never influenced my husband to take a job. Later we started driving east from Chicago; Karl was much too engrossed in his thoughts to pay attention to his driving, so I drove. He hadn't said a word.

"Are you going to take it?" I said.

"No."

"Why?" I asked.

"I think it's more important to get back and pull Tech together than take that commission," he answered.

"Karl was a great man if I do say so — he really was a great human being. I'm sorry, in one way: in his biographies, it always says how much people loved him; they thought of him as a human being of warm, wise qualities. But he wasn't thought of as a scientist. I think he should have been given more recognition of his work at Princeton with Van de Graaff on the linear accelerator."

"It's been a good, exciting, very very rewarding life. I've been glad Karl decided to come to M.I.T.— we spent nine years at Princeton; everyone said one needed ten

"President's wives ask how much energy to put in — I say *all* of it. *Sink* it, for heavens sake — that's what you're there for. But don't try to make his decisions; your marriage will depend on it."

"No one who has watched science would dare to predict the future . . . Someone will find something on his lab table that will change things. The point is, those lab tables have to be free to go in any direction."

(Above) on June 11, 1948, the late Luis DeFlorez, '11, landed his seaplane in the Charles River Basin and tied up at the M.I.T. Sailing Pavilion. Lester D. Gardner, '98, presented Mrs. Margaret Compton with gifts from the world's air lines in recognition of the part which M.I.T. has played in the development of world aviation. At the Sailing Pavilion, (left to right): Luis de Florez, '11, Lester D. Gardner, '98, Mrs. Compton, and President Compton. (Photo: M.I.T. Historical Collections)

years to be accepted. But I never did really fit in at Princeton.

"I've always had a great regard for science, although I'm the last person to do something in science; I couldn't pass the entrance exam. I've been excited about living among scientists at M.I.T.; and it encourages thinking in my own mind."

"And what of M.I.T.'s future?" I asked.

"No one who has watched science would dare to predict the future," she emphasized. "Someone will find something on his lab table that will change things.

"The point is," she continues, "those lab tables have to be free to go in any direction — and that's where Tech has been preeminent — in allowing faculty and students to go where science led."

A Wife's Role

I asked about the responsibilities of the first lady.

"It's the same as the responsibility of any wife of a man doing creative work," she explained. "She supplements him if she can, and supports him. In a college, she has an open-heartedness toward the students. It has been my role here to open avenues for women, and it's exciting to see a woman as chairman of the faculty — and a good one." Her eyes are bright.

"When I look at the whole picture of the role of the wife of a man of public affairs, I see what a rich opportunity she has. She doesn't need a paying job of her own to have fulfillment — she's got it in working with him on his job. I couldn't imagine a marriage without that. I'm sure I had a far richer experience than I would have on my own. But *that* depends on marrying someone who's got what it takes!"

"President's wives ask how much energy to put in — I say *all* of it. *Sink* it, for heavens sake — that's what you're there for. But *don't* try to make his decisions; your marriage will depend on it."

"What happens when a woman wants her own career?" I ventured. "M.I.T. women are geared for that," I added.

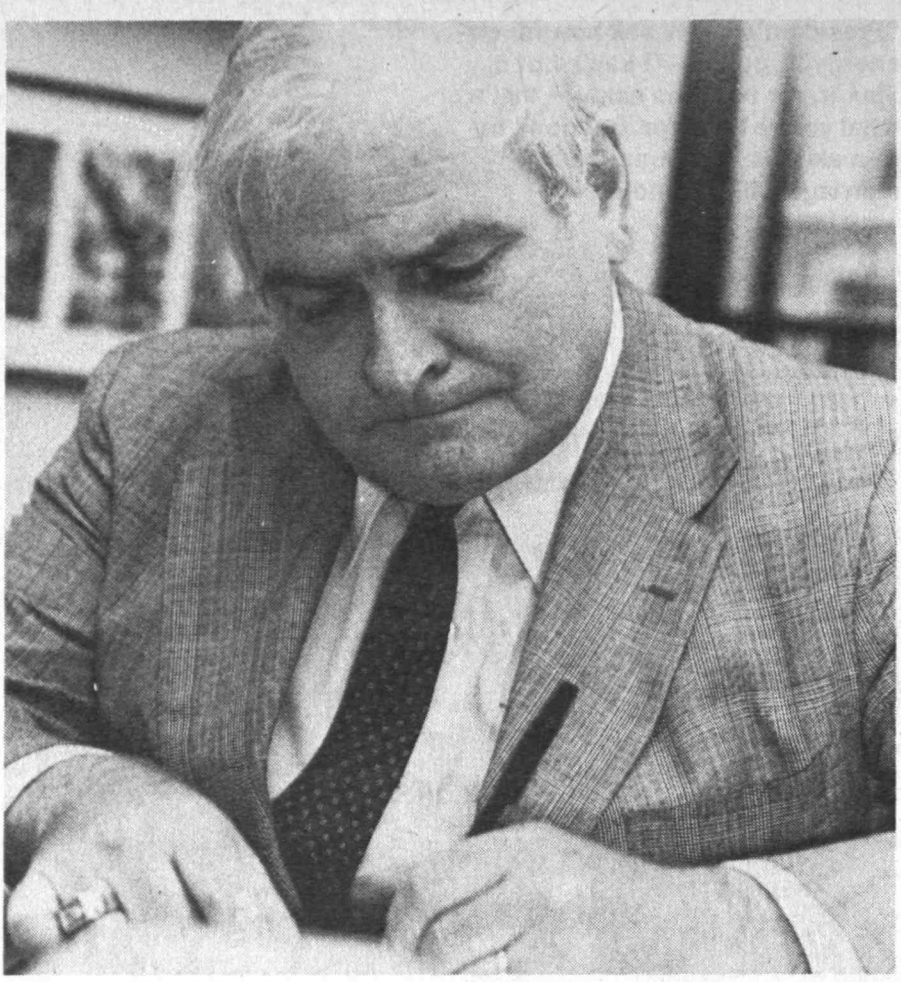
"If a woman wants a career of her own, that is hazardous for marriage," she said. "But women are proving that they *can* succeed in both marriage and a career; I've seen some good marriages among alumni with two careers," she added.

Positive Influences

Margaret Compton was 89 last July; she was born in 1892. "It amuses me," she says, "when they talk of old people and senior citizens over 65. That seems so young to me.

"A lot has to do with the circumstances of your life, going back to early childhood. The influences in the home are so continually operative; and sometimes the influences show up more during old age.

"My father, my mother, the church, and schooling, were all positive. I don't remember the negative." — *M.L.*



When Paul E. Gray, '54, sat down at his desk at M.I.T. on Tuesday, July 1, he was president of the Institute – no longer its chancellor. (It was the same old desk; the President's Office was being redecorated for its new occupant.) Dr. Gray's first official act (above) was to accept for M.I.T. a gift of shares in Keithley Instruments, Inc., Cleveland, Ohio. They were from Joseph F. Keithley, '37 – the nucleus, Mr. Keithley hopes, of a fund which will eventually support a career development professorship in the Department of Electrical Engineering and Computer Science. The timing was no accident; Mr. Keithley wanted his gift to "mark an auspicious beginning for a new administration," and Dr. Gray assured him that it did. (Photo: D.J. Dudzik)

$1.69 Million from Sea Grant

M.I.T.'s Sea Grant funds for 1980-81 will total $1.69 million from the Office of Sea Grant in the National Oceanographic and Atmospheric Administration, and some projects will claim matching funds from industrial or local government co-sponsors. In general, the program will focus on resource development, planning, waste conversion, marine pollution, and the effects of human activities on marine and aquatic resources.

$1.5 Million from Japan

Two major grants came to the Institute from Japan as the summer began:

☐ A total of $500,000 over five years from the Mitsui Group, one of Japan's oldest and largest industrial organizations, will support young faculty working on problems of technological growth in industrial countries.

☐ The Japanese government provided a unique $1 million fund to serve as a permanent Japanese Endowment for International Energy Policy Studies. The income will support Energy Laboratory work in the international aspects of energy policy, with expanded collaboration with Japanese scholars and institutions.

The Mitsui grant will cover career development professorships in such areas as pollution, urban design and planning, transportation, and health.

Living with "a Bunch of Weirdos"?

Bexley Hall won't be co-ed this fall after all; neither of two proposals has won effective adherents. One plan would have had one Bexley entry turned over to women who wanted to live in a single-sex environment where they could do their own cooking; McCormick Hall's dining room will be reopened this fall, and all residents will eat there. Bexley's male residents objected strenuously; they feared "the character of their dorm would be changed," said *The Tech*.

Meanwhile, some Bexley residents — and some nonresident women — were proposing that Bexley go co-ed in the usual, integrated way. Robin Miller, '83, explained that she wanted to move to Bexley "because of its excellent cooking facilities. It doesn't bother me that there are a bunch of weirdos there," she told *The Tech*'s John E. Link, '83. That plan failed when time ran out without strong proponents. So Bexley chairman Christopher S. Wendel, '81, told Mr. Link that "apparently no women will be living in Bexley legally next fall."

Honored by the Academy

Eight members of the M.I.T. community were chosen by the American Academy of Arts and Sciences this spring; the Academy describes itself as a national honorary society with members chosen from the mathematical, physical, and biological sciences, law, administration, public affairs, theology, fine arts, and the humanities. The new members: **Emilio Bizzi**, professor of neurophysiology at M.I.T.; **Carolyn Cohen**, Ph.D.'54, professor of biology at Brandeis University; **Rudiger Dornbusch**, professor of economics at M.I.T.; **Merton C. Flemings**, '51, Ford Professor of Engineering (metallurgy) at M.I.T.; **Jerome I. Friedman**, professor of physics at M.I.T.; **Ralph Landau**, Sc.D.'41, chairman and chief executive officer of Halcon International, Inc.; **Joaquin M. Luttinger**, '44, professor of physics at Columbia University; and **Robert N. Noyce**, Ph.D.'53, chairman of the board of Intel Corp.

Outstanding Teams in Karate and Table Tennis

A five-man team from the M.I.T. Shotokan Karate Club placed second in the New England Collegiate Karate Conference (NECKC) this spring, losing only to Boston University in the form (kata) event and to Boston College in the free-sparring (kumite) event. James Davis, a graduate student in electrical engineering, was listed as one of the NECKC's five best combatants.

Meanwhile, the table tennis team capped a 13-1 season by winning the Greater Boston Intercollegiate Table Tennis Tournament, and Jeffrey S. Lu, '83, won second in the individual championship.

In the Footsteps of Marco Polo

by Steven Solnick, '81

By just about any standard I can think of, Washington, D.C. has got to set the standard for "civilization" in the United States today.

As I packed up my room over the course of 48 consecutive hours at the end of May (it's amazing how much junk you can accumulate in a room in just three years) I was not exactly brimming at the prospect of three months in beeyootiful Washington. Everyone kept telling me how lousy the weather was and very little else. I thought longingly of Boston and could not rid myself of the feeling that I was leaving a cultural Mecca for a hot, sticky, bureaucratic tourist trap.

I was right.

There was one attribute of our nation's capital which I overlooked, however. Just about everyone here works for the government including, now, myself. The government as a matter of course provides its employees with the three necessary ingredients for a "civilized" existence: free phones, free Xerox and free mail. Refinement just flourishes in an environment like that.

Add the Smithsonian, Library of Congress, Kennedy Center, a quiet subway, the National Zoo and the entire Federal Government and you just can't miss (the last two items really are different). If Boston is like Athens in its Golden Age then Washington must be Rome under Caesar. Or at least, these days, Rome under Claudius.

I can't help wondering how well three years at M.I.T. has prepared me to cope with such a massive dose of "civilization." I decided to keep a brief tally.

I was wandering through the Hirshhorn the other day — my favorite of the Smithsonian's art museuems and a great place to meet young secretaries on their lunch hour. I was captivated suddenly by an odd four-foot sculpture. It was a bizarre African sort of thing but I couldn't help thinking I'd seen it before. When I finally came to my senses and looked at the name plate I discovered it was a piece by Jacques Lipchitz. I realized with a start that Lipchitz created the sculpture garden in the court of Hayden Library. Here I was, standing in front of a sculpture in Washington, recognizing the sculptor from my experience at M.I.T. In the next five minutes I came across pieces by Henry Moore and Louise Nevelson, both of whom are also represented on the M.I.T. campus.

I was blown away. I mean it's one thing for M.I.T. to teach me to recognize an elliptical integral; it's quite another to realize it's also teaching me to recognize scupltors. Not bad for an engineering trade school.

M.I.T. 1; Civilization 0.

The next day I was at the East Wing of the National Gallery of Art when I found myself staring at a 20-degree point jutting out from the building. "Building 66," I muttered to myself, scaring off more than one member of a giddy family from Montana.

The building was designed of course by I.M. Pei. No self-respecting Tech student can help but recognize one of Pei's buildings when he sees it in the flesh.

That's two for the old alma mater.

But all is not roses for the M.I.T. student in Governmentville. I was hardly prepared for being reprimanded by a policeman near the Capitol for jaywalking. Jaywalking! In Boston you get compliments for a good jaywalk; here you get a ticket. When you couple that injunction with cab drivers who are actually *courteous*, you're in for some culture shock.

It's all a manifestation of that aspect of "civilization" generally known as "manners." Let's face it, M.I.T. is not exactly a "mannered" college — we're all a bit too busy for that. I don't mean to say we're rude, of course, but there are some niceties that just require a bit too much effort.

Like waiting in a *line* for a bus. They do that in D.C.; transgressors are socially ostracized. It takes a little getting used to, coming from the Mass. Ave. commuter training ground where we wait in a *mob* for a bus.

Or wearing a tie in the evening. You see a lot of that here. I suppose that really is the "civilized" thing to do but after three years at M.I.T. the only cases of Tie-After-Dark I've seen (other than semi-formals) have been at Harvard. In a lot of ways, Washington is like one big Harvard.

Except you hear the letter "r" in Washington. I wasn't really ready for that and I may have a traumatic time readjusting to Bahston in September.

M.I.T. 2; Civilization 4.

One further pitfall in the economics of "civilization" arises at meal time. I've been on the points system on M.I.T. Commons for a few years. Under that system, breakfast is one "point," lunch is three and dinner is four. Each point costs about a dollar. So after a while you start to think it's natural to pay one dollar for breakfast, three for lunch and four for dinner.

What you quickly forget is that when you pay for it with real bucks instead of funny money points, eight dollars a day for food is ridiculous. You end up broke in no time (There are plenty of beggars here but they're all exceedingly polite; probably ex-lobbyists).

Yet at the same time, *Washingtonian* magazine classes an "inexpensive" dinner as "under $30 for two with aperatif, three courses and wine." In my book an inexpensive dinner is still "under $7.50 for four at Elsies in Harvard Square for a sandwich and potato salad."

Final score: M.I.T. 2; Civilization 5.

It doesn't look good for old Technology. Maybe it's time for a banner headline in *The Tech*: "M.I.T. drubbed by civilization." Or a special faculty meeting at the very least to design a subject: "Preparing for the Civilized World." Or a whole new department: "Societal Intercourse Engineering."

Stop the presses.

The one vital observation I'm leaving out here is the intangible look of recognition I notice crossing even the most "civilized" face when it hears the name M.I.T. Even in this Harvard of 1 million strong, we're the only school of its kind. Harvard blends with Yale blends with Princeton blends with. . . . But M.I.T. has its *own* special place in this civilization. A Brass Rat is instant legitimacy.

And when you've got that you can fake the rest.

Steven Solnick, '81, is a physics major and Editor of The Tech.

Mt. St. Helens Blew Up in Front of Him

As I drove down the dirt logging road, I thought, "Maybe I waited too long."

Alone on a week-end camping trip, Keith Ronnholm, '73, who is now a graduate student in geophysics at the University of Washington, had driven to a spot near Mount St. Helens on Saturday, May 17. Eighteen hours later he was thrust into an unexpected and totally astonishing world: Mount St. Helens blew up directly in front of him.

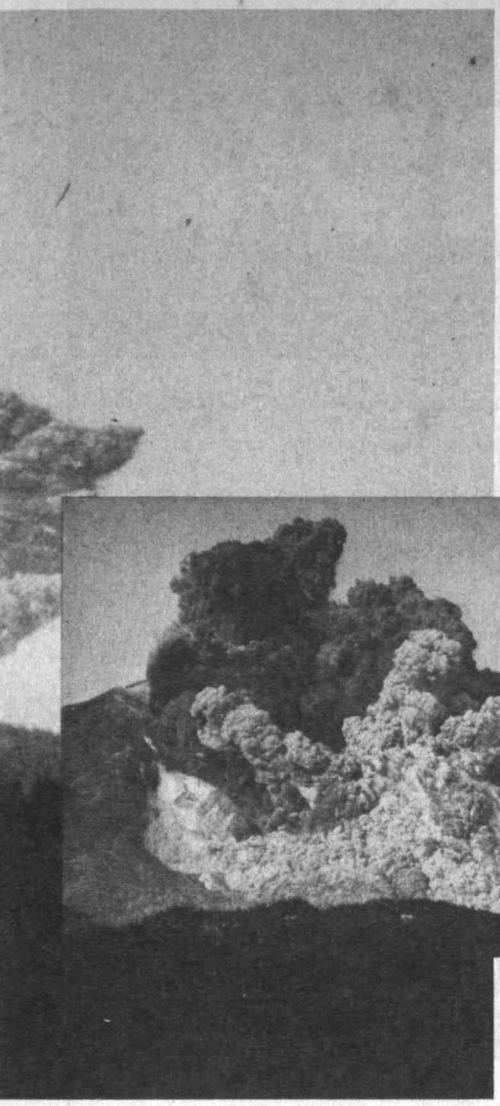
"A yell from another party camping alerted me that something was happening," he told me. "As I looked up, I saw the whole north side of the mountain sliding down. I couldn't decide whether to just watch (if it was a landslide it might be over in a few seconds) or to take photographs. But then ash began to billow out from the mountain; I knew it was an eruption and grabbed my camera. As I watched the cloud expand, I began to wonder how far it would travel and if I was too close. Then it hit a ridge and began to churn and boil vertically, so I was less worried. However, I soon realized I had better leave.

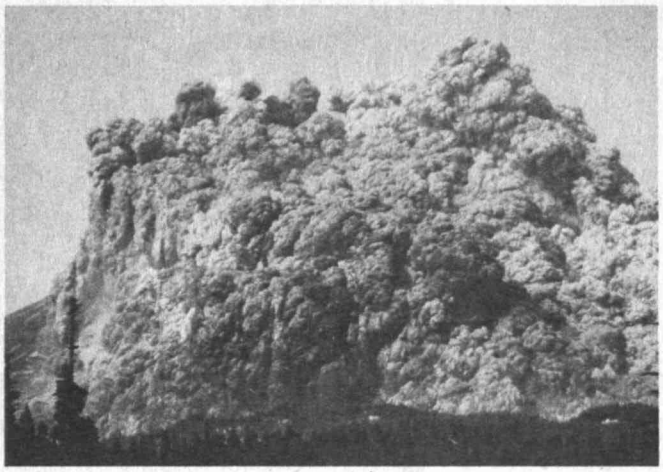
"By the time I had turned the truck around and snapped a few more pictures, the ash cloud was no more than two miles away. The two ridges between me and the mountain were obscured, and as I drove at 50 miles per hour down the dirt logging road I thought, "Maybe I waited too long." About three miles from the viewpoint, as I stopped to take more pictures, I heard some noises in the forest that I thought were animals frightened by the thunder. But when the first golf-ball-sized rock hit the road ten feet away, leaving a small crater, I grabbed the rock and headed out fast.

"The rocks were replaced by drops of mud. Gradually it got darker as the ash cloud obscured the sun. I turned on my headlights. The mud drops dried out and became a heavy, dry, dark snowfall," and Keith was engulfed.

"I couldn't see ten feet in front of me," he said. "The only way I could discern anything was to look out the side window of my car and pick out the contrast between the green grass and the dark pavement. Then the road took a sharp turn — and I didn't know where it went. I drove into a ditch twice. It was a rugged mountain road with no guardrails, and I was thinking that before I went over a cliff it would be better to stop."

He pulled over to the side to wait. "I was thirsty, so I reached over to pull a 7-Up out of my cooler, and sat there in the dark, sipping it. I wasn't worried about waiting it out





Keith Ronnholm, '73, was camping near Mount St. Helen's when the volcano erupted. He took these photographs while escaping from the area. (Photos: © 1980 by Keith Ronnholm)

— I had a pick-up with a canopy in the back, stocked with plenty of food and water, books, and camping supplies. If the ash settled to a depth of a few inches I'd be fine; if it covered the car, I'd suffocate.

"I'm a pretty confident person," he told me, "I knew I would get out, but I worried how. I'm less scared when alone, because then I'm not responsible for anyone else. I wasn't worried about poisonous gas; I figured I was about 20 miles away from the volcano. And my position was separated from it by two ridges, so any lava flows would follow gravity and would not head towards me. (The blast, I found out later, had killed people up to 25 miles away and came within 1/2 mile of my original camp site.)"

Suddenly a logging truck appeared, two men wearing hard hats running out front to direct it along the road, ten men in the truck.

Keith rolled down his window. "Can you see anything?" he yelled to the truckers, waving so they could see someone was in the car.

"No, but we've got guys in front; follow us."

"It was sort of controlled panic," Keith continued. "I stuck to the truck, following about one inch behind it. The loggers ran in shifts up front."

"Are We Going to Be Hit?"

"After about five miles of pitch dark, with our headlights on (it was 10:30 a.m.), the visibility improved to about 100 feet. It took us one hour to go about 25 miles. We got off the logging road and onto the state highway in Randall.

"When we got to the town, it was pitch dark, there were no police, and no streetlights. The loggers pulled into a logging camp; I continued into town. The people were frazzled. I went with two other men to a house and asked if they had any room; they said they had all they could handle and directed us to a church. There were a lot of kids in the church from an environmental camp that had evacuated into town."

"Are we going to be hit by lava flows?" everyone asked.

The newspapers had warned of that possibility.

"Forget that, just get inside and get the stuff out of your eyes and hair; stop breathing it," Keith told them.

After he was in Randall for one and one-half hours, finally the static on his radio (caused by lightning from the volcano) lessened, and he could hear a voice from outside. The ash was travelling east, the broadcaster said, so Keith decided to chance it and start driving west.

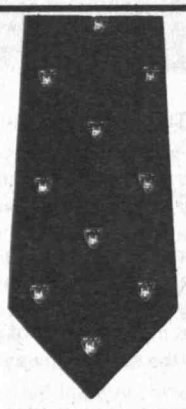
"After one and one-half hours I was in bright sunlight. I changed my course towards the south and east, to see the plumes of ash rising in the distance.

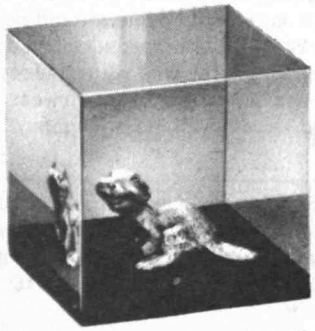
"We could have been better prepared," Keith explained. "The radio stations kept soothing the people in Seattle — 'Don't worry, the ash is going to Yakima.' In stricken areas, there were no police (it was dangerous for them to come in) and no directions. What radio broadcasters needed to do was tell people who were trapped in the darkness how to get out (head west, not east), and to deal with the emergency." — *M.L.*

Keith Ronnholm is making prints, slides, and posters of the volcano's eruption available. For further information, contact him at 6233 39th Ave. NE, Seattle WA 98815.

M.I.T. INSIGNIA

A GOOD WAY TO REMEMBER





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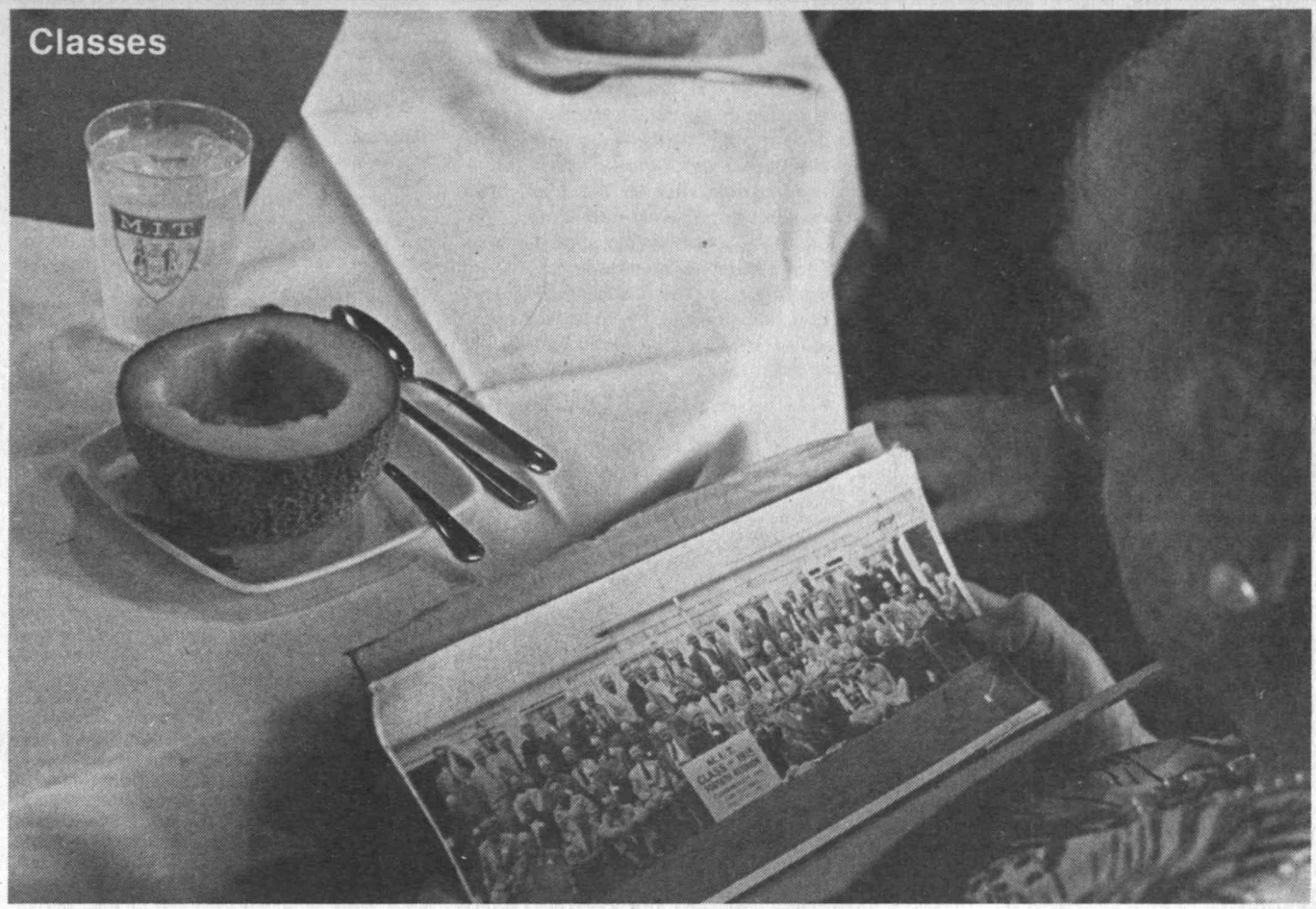


Browsing through class pictures, a favored reunion pastime, was a typical sight at the Technology Day luncheon in June. The Class of 1915, shown above at their 40th Reunion, were back this year to celebrate their 65th Reunion (see page B12). (Photo: Gordon R. Haff, '79)

04

Jane Bielski writes to report the death of her father, **Eugene H. Russell, Jr.**, on March 27, 1980, at the of age 97. She says, "He was always very proud of his affiliation with M.I.T., and at one time active as class secretary. . . . His family was fortunate to have him with us for so long, and it has been a comfort to know he enjoyed life to the end." Mr. Russell lived in Needham for more than 50 years and was associated with Equitable Life and John C. Paige Agency of Boston.

From a news clipping we have word of the death of **Eliot W. Niles**, 99, on June 27, 1980. He retired in 1945 after serving 40 years with Bell Telephone. Before joining the engineering department of American Telephone and Telegraph Co., he was an assistant instructor in physics at M.I.T. — *ed.*

10

When we think of 1910 class notes, it is natural that we think of **"Jack" Babcock**, our long-time class agent and also our present permanent class secretary. Many will remember that "Jack" received the Bronze Beaver Award of the Alumni Association in 1978 in recognition of his faithful services as "a distinguished member of the faculty and as an active alumnus."

Now we have to report that "Jack" Babcock is no longer able to serve as our class secretary. In consequence, our permanent class president has undertaken to prepare the following report so that our class members may be somewhat up to date as of Technology Day, 1980, the 70th anniversary of our graduation.

During the spring we tried to obtain recent information concerning our surviving class members by a postcard survey. In all, 22 postcards were sent to all class members whose addresses were available from Alumni Association records; 18 replies were received. No responses came from **Karl W. Gasche**, **H. Gordon Hawes**, **George R. Lord**, and **Manuel A. Navarro**. Five replies reported the deaths of classmates; namely, **John A. Holbrook** died Christmas Eve, 1977; **Edmund B. Kiley** died July 4, 1979; **Charles F. Robinson** died April 17, 1979; **Walter T. Spalding** died January 12, 1979; and **Charles William Wallour** died in March 1979.

Thirteen postcard replies were received from living classmates. The average age of our living classmates is indicated to be about 93 years. Three younger classmates are 91 years old and one, **George S. Thomas**, is 101 years old; he resides at Carroll Health Center, 2241 No. West St., Apt. 19, Carroll, IA 51401.

Replies were as follows:

— **Harold E. Akerly** reported that his wife is blind and has had several strokes; however, they live in an apartment, drive, and eat out occasionally. He sends best wishes to all.

— **John B. Babcock, III** resides at Seaside Nursing and Retirement Home, 850 Baxter Blvd., Portland, ME 04103. **Fred Lufkin** calls on him about twice a week.

— **Cecil K. Blanchard** has used his leisure time to work with his retired son in Maine remodelling a schoolhouse and an old farmhouse.

— **Stuart Chase** had a successful operation for a malignancy in April 1979, and reports he is recovering nicely, even to splitting logs for the fireplace.

— **Arthur H. Curtis**, our permanent vice president, reports that his wife, Mary, had the misfortune to fracture a hip but is now recuperating at home. Arthur goes to business regularly and enjoys tolerably good health.

— **Ralph W. Horne**, our permanent president, believes himself to be in good health and goes to business about twice each week; once at Fay, Spoford & Thorndike, Inc., of Boston, Mass., where he has the designation of consultant and director emeritus, and once in his home city, Malden, Mass., where he is vice president at the First National Bank of Malden. Ralph was recently listed among the biographees in the Marquis publication, *Who's Who in America*. He reports the sudden death of his wife, Meta, on December 10, 1979.

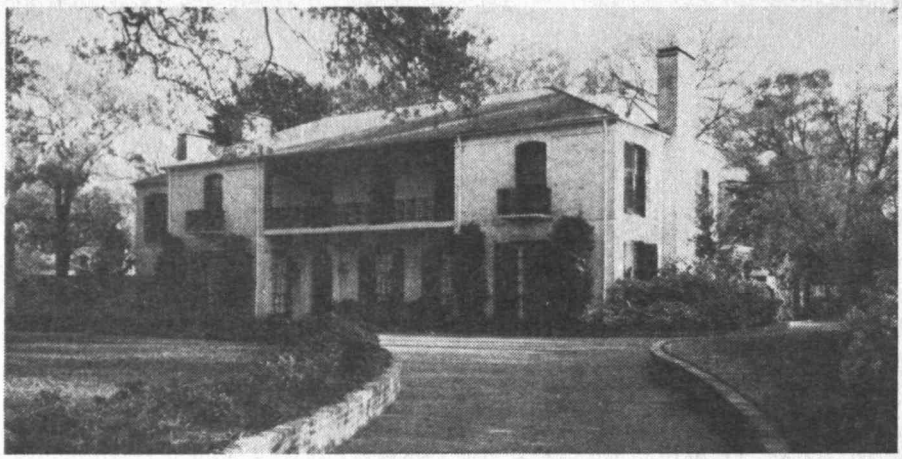
— **Carl H. Lovejoy** is in good health and attributes it to keeping active, walking one mile daily, travel, winters in Florida, and enjoying life with his wife, Glenna.

— **Fred T. Lufkin** is in fair health except for his hearing which he rates as poor. He faithfully makes regular calls on "J.B." at the nursing home to make sure he is comfortable and contented.

— **French P. Sargeant** reports his hearing and eyesight to be fair but his walking is poor because of his having had a leg amputation in 1974.

— **Max C. Sherman** reports fair hearing and poor eyesight, and says he walks poorly. He lost his wife after being married 68 years. He has resided since 1977 at "Crosslands", where his address is

Much of the character of Houston's best residential areas in the 1920s and 1930s was set by John F. Staub. '15 (left), "the ablest residential architect practicing in Texas during the 1920s," says Professor Howard Barnstone of the University of Houston in a new book. Mr. Staub practiced architecture for 50 years in Houston beginning in 1921, concentrating almost exclusively on residential commissions. The photograph, from The Architecture of John F. Staub: Houston and the South, *shows the house in River Oaks designed in 1935 for Mr. and Mrs. Robert Bowles.*



Chronicling John F. Staub's Pervasive Influence on Houston

John F. Staub, '15, began to practice architecture in Houston in 1921. Fifty years later, when he closed his office, more than 100 of Houston's most elegant residences — and another 50 or more elsewhere in Texas and throughout the south — owed both their form and detail to his genius. Though their style is traditional and eclectic — elements selected from pre-existing sources applied in a new context — they have some fundamental characteristics of "modern" work: "Their detail is spare, their spaces large and unimpeded. . ."

The quotation is from the forward (by Vincent Scully) to a sumptuous new book in which Howard Barnstone, professor of architecture at the University of Houston. chronicles Mr. Staub's career and lists in detail the many developments and houses through which he set the character of Houston's best residential districts in the first half of the 20th century: *The Architecture of John F. Staub — Houston and the South*. (Austin, Tex., and London: University of Texas Press, 1979; $35).

Mr. Staub came to M.I.T. in 1913 after graduating from the University of Tennessee, intent on an architectural career which materialized when he joined the office of Harrie T. Lindeberg, a fashionable New York country house architect, in 1916. He moved to Texas when Mr. Lindeberg sent John Staub to supervise several commissions in Houston in 1921; two years later Lindeberg withdrew, and Mr. Staub entered practice in his own right.

It was a busy time — an ideal moment for a new architect, with the appropriate introduction to Houston society provided by his previous employer. The ship canal linking Houston to the Gulf of Mexico was complete, and every year brought new evidence of the size and importance of Texas oil resources. Staub quickly became the principal architect for new homes for the leaders of this new prosperity, and Professor Barnstone calls him "the ablest residential architect practicing in Texas during the 1920s.

"Staub's virtuosity — his style — ironically emerged as one of self-effacement. Graceful accommodation, enlivened by subtle wit and keen taste, produced an aesthetic of the unassuming. . . . Formal virtuosity found its proper location not in the exposition of the novel or the extraordinary but in superior technical facility."

Even the "modern" houses designed during the last years of his practice reveal what Professor Barnstone calls "the fundamental concern in forming all of Staub's domestic work: the provision of personal amenity and comfort. the values of this architecture are concrete — accommodation and convenience — and in Staub's work they are always present." — *J.M.*

Box 267, Audland House, Kennett Square, PA 19348.

— **Lewis S. Southwick** reports that his hearing is good, his eyesight fair, and his walk fair. He lists two outstanding experiences: he climbed the Matterhorn in Switzerland and with his wife made one of the first commercial air flights between Paris and London.

— **George S. Thomas**, previously referred to herein as being 101 years of age, is apparently our oldest living 1910 classmate. Congratulations, and we will wish you future good health and happiness. Our postcard reply regarding George indicated that his hearing is fair, his eyesight is good, but he does poorly when it comes to walking. Well, George, don't let that worry you. There are quite a few of your 1910 classmates who have "given up" jogging!

— **Chester W. Wilson** reports that "somehow memory is poor"; says his hearing is poor and he uses a hearing aid; says his eyesight is fair but only one eye is useable; but he is good at walking.

Ralph W. Horne as permanent class president, and **Arthur H. Curtis** permanent class vice president, concluded that our classmates would like to see in *Technology Review* a statement that the Class of 1910 was represented to some extent on Technology Day, even though a decision had been made that there would not be a 70th year reunion. We found that we were assigned a table to accommodate 10 people marked 1910-1913 among a sea of white tablecloths in Rockwell Cage; actually, members of the Classes of 1903, 1910, and 1913 occupied our table. Our president was seated beside John J. Nolan '03, 99 years of age, from Louisville, KY. Mr. Nolan's son, also a graduate of M.I.T., accompanied his father, and they planned to fly back to their home following the luncheon festivities. Our 1910 representatives enjoyed reminiscing with our tablemates regarding the early days, and two class representatives felt well rewarded for having attended. — **Ralph W. Horne**, Acting Secretary, 14 Winn Ter. Malden, MA 02148

13

There's not much news for this issue as I have had no communication with either the Alumni Office or members of 1913.

I was in touch with **Charlotte Sage** recently and learned that she is planning to spend another summer at Whitingham, Vt. with frequent visits from grandchildren and great grandchildren.

Charlotte attended the Alumni Day luncheon with her friend and M.I.T. associate, Grace Farrell, '29. Also at the luncheon from 1913 were **Walter Muther** and **Warren Glancy** and Walter's daughter, Sally Lawton.

Stay well and happy and send me some news. — **Rosalind R. Capen**, Assistant Secretary and Treasurer, Granite Point Rd., Biddleford, ME 04005

14

Raymond D. MacCart died in the naval hospital near his home in Chevy Chase, Md., on May 11, 1980. He was with us in all four years, received his bachelor's degree in Course II, and in 1915 received a master's degree from the Institute. In the latter part of 1917 he was in the Naval Aviation ground school at the Institute and, after further training at an aircraft plant in Buffalo, was commissioned an ensign in the U.S. Naval Reserve in 1918. In the fall of that year Ray was among the officers selected to take a graduate course in aeronautics at M.I.T., and early in 1919 was assigned to the aviation section of the Bureau of Construction and Repair in Washington. When the Bureau of Aeronautics was organized later in that year, he was among the officers who made up its original staff. After qualifying by examination, Ray became a lieutenant in the regular navy in 1920. In the years after that he stationed at the Naval Aircraft Factory in Philadelphia and, as Inspector of Naval Aircraft, at contractors' plants in Buffalo and Long Island City, N.Y., Hatboro, Penn., and

Members of the Class of 1916 and their guests returned to Chatham Bars Inn on Cape Cod for their 64th Reunion. Standing, left to right, are Frieda Ullian, Irene and George R. Crowell, Sibyl Fletcher, Cynthia Robinson, Frances Duff, Bruce and Betty Crowell and Rose O'Brien. Seated are Nat Warshaw, Hy Ullian, George I. Crowell, Ralph Fletcher, Paul Duff, Barney Gordon, and honorary member Bob O'Brien.

San Diego, Calif.

On leaving the Navy in 1945, Ray went to Brown Brothers Foundry in Stamford, Conn., and became its president in 1948. Later, in Stamford, he was president of Manufacturers Acceptance Co., division manager of Petroleum Heat and Power Co., and chairman of the Stamford-Greenwich Manufacturers Council. On his retirement, Ray moved back to Washington and for some years had an apartment also in Pompano Beach, Fla. In 1919 he married Virginia Kramer Rahm. She survives him, as does a niece, Mrs. E. Arthur Bonney, of Severna Park, Md.

Robert Parsons died on March 21, 1980. He joined our class in our sophomore year and received his bachelor's degree in Course VII. During the first five years of his career he lived in New York City and in Pittsburgh, and in 1919 was a chemist with American Sugar Refining Co. Later he was with Parke, Davis and Co. and lived in Lynn and Swampscott; from 1937 until his retirement his home was in Marblehead. For the past ten years he had lived in Beverly. His main outside interests during his active years were stamp and coin collecting and genealogy. He taught several adult education courses in the latter subject in Boston and was the official genealogist of the Lynn Historical Society for a number of years. During his retirement years, Robert's activitites were a good deal restricted by arthritis, but he nevertheless made a trip to London which meant much to him because of his interest in English history. He is survived by his wife, the former Marjorie Blackstone Smithwick; they had been married for 43 years. — **Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, CT

15

At this age trying to keep up with class notes gets tougher and tougher. But here goes! The contributions to **Joyce Brado**'s collection for the annual Alumni Fund continue remarkably well.

Evers Burtner reported the following classmates at the Alumni Day luncheon for our 65th Reunion: **Mary Plummer Rice**, **John Homan**, **Horatio Lamson**, **Wally Pike** and himself — a loyal group. Laid up with the results of my recent stroke, I regretably could not be there. Wally Pike had as guests his daughter Marion, Barbara Thomas, her daughter Virginia and husband Paul Johnston ('32), and **Bernie Landers**. A fine attendance for our age!

Here is Evers' first-hand account of the reunion: "John Homan expressed a special desire to eat at Anthony's Pier 4, so he, Mary Plummer Rice, Mrs. Dorothy Adler (from the M.I.T. Alumni Center), and I went there. The next morning I showed John the Nautical Museum at M.I.T. of which I was curator for 15 years after Admiral Cochrane. We then drove to Kingston and recalled M.I.T. and the old yachting days. John was in charge of research at United Shoe for many years and now lives in Florida. Sunday morning his son and grandson came from Marblehead to take him to their home for a few days."

Here's a fine letter from Mimi (Marion, to us) Rice — loyal and active as ever. She's wonderful! "It was a fine reunion even though only six of the class could attend. As a guest in McCormick Hall, I'm always entertained as a (distant) cousin of Katherine Dexter McCormick, who I had the honor of meeting in 1965 at our 50th Reunion. The name Dexter goes back eight generations to 1629.

"I am returning to California where I moved last November hoping to avoid the snow and ice of the east. Instead, I passed a winter of almost constant rain and wind, but the nighttime temperature seldom went lower than 30°. In August I'll go to Vancouver, B.C., and then spend the Christmas holidays in Puerto Rico (San Juan) with my son who is an account executive at Bache and Co."

Frank Hull boasts of his 91 years of age; he plays golf regularly in Florida — good for him! . . . And **Jim Tobey** writes, "I was hoping to attend the 65th Reunion and regret that I couldn't. For a dozen years or so I have had a mild heart condition which flares up occasionally when I get too much sodium in my diet. Then the ankles and legs swell and I have to add to my usual intake of diuretics and stay close to the comfort station. My best regards to those who were present."

It's sad to report the passing of these good classmates who died recently: **Phil Alger**, **Harold Bassett**, **Philip Codwise**, **Frank Boynton**, **Frank Parsons**, **Larry Quirk**, **Arthur Bond**, Dr. **Louis Finck**, **William M. Harbaugh**, and **Charlie Norton**. The sympathy of our Class goes to all their families.

All the best to you all — **Azel Mack**, Secretary, 7 Atwood St., Wellesley, MA 02181

16 65th Reunion

Our 64th Reunion at Chatham Bars Inn was a delightful experience. The weather was marginal but the dispositions of our classmates were sunny and warm. The personnel at the Inn contributes greatly to the joy and comfort of our stay and we look forward to enjoying their hospitality again. The following attended part or all of the reunion: Frances and **Paul Duff**; Frieda and **Hy Ullian**; **George Crowell** with his sons, Bruce and George, and their respective wives, Betty and Irene; **Nat Warshaw**; **Barney Gordon**; Rose and **Bob O'Brien**; Sibyl and **Ralph Fletcher** and daughter, Cynthia Robinson. We had a last minute cancellation from Marjorie and **Don Webster**. We had a continuing discussion of our 65th and how to make it easy for all interested classmates to attend. We considered possible locations, transportation assistance, special events, and the possibility of an underwriting fund created by special contributions as a way of keeping the individual reunion cost reasonable. You can help us by volunteering your ideas early so that our efforts will bring the highest possible attendance. Some of us have been attending these annual reunions since 1951. **Francis Stern** expressed it nicely when he wrote of his inability to attend our 64th: "Gladys and I both find it hard to express our disappointment. Although the group had gradually grown smaller, there has been a togetherness with the Spirit of '16 which had made each year a fond souvenir to look forward to its renewal." If you share this feeling and find obstacles in your path towards attendance at our 65th, write us and see what help we might give to remove those obstacles.

Let's use the example of **Val Endicott** who, in sending his regrets for the 64th, wrote: "I will try hard to go next year to '16's' 65th"; and, **Will Wylde**, who wrote: "Sorry but I just can't make two trips north each year and we always go up to an annual family reunion each year in late August. Maybe in '81, we can make a special arrangement for this special event."

This year Don Webster's back trouble "makes getting about a chore, so I regret Marjorie and I will not be with you at Chatham." **Henry Shepard** expressed his regrets: "I have been losing energy rapidly for the past six months and get very tired going away from home. I still am able to take short walks — no illness — it just seems to be old age." **Charlie McCarthy** wrote: "I wish I could tell you that Betty and I will be coming to the Reunion in June. Unfortunately, I must send our regrets. I am in good shape — reasonable wear and tear considered." **Vert Young** expressed what so many others' indicated: "I fear our travelling days are over." **Jap Carr**: "Sorry, have an important busi-

Thanks to the generosity of the Class of 1917, a panoramic history of M.I.T. from 1846 to 1980 now adorns the corridor leading to M.I.T. Alumni Center in Building 10. To celebrate its opening, just before Technology Day, seven members of the class came to inspect the materials selected and arranged by Warren Seamans and his staff from M.I.T. Historical Collections. Left to right: Stanley C. Dunning, Philip N. Cristal, Donald P. Severance, '38, Julius A. Stratton, '23, Jesse A. Rogers, Jr., Raymond Stevens, and Stanley M. Lane. (Messrs. Severance and Stratton are honorary members of the class.)

ness meeting in Florida on June 2." **Dan Comisky**: "Sorry, unable to come as convalescing is taking longer than anticipated."

Unfortunately, the Reunion solicitation brought back notices of deaths: **Ben Kerstein** passed away in January, 1980. **Herb Ellis** left us on May 16, 1980. **John Fairfield**'s wife, Gladys, died in November, 1979. **George Maverick** died on April 23, 1980. **James "Dip" McClure** departed on February 27, 1980. May they rest in peace.

Keep the letters coming and keep breathing and keep walking.— **Ralph A. Fletcher**, Acting Secretary, Groton Rd., West Chelmsford, MA 01824

17

Several months ago, the Class of 1917 voted to fund, from their undistributed income, a sum of money for the purpose of decorating a rather barren corridor leading from the foyer of Building 10, to the Compton Gallery. The task was undertaken by the M.I.T. Historical Collections, under the supervision of Warren Seamans, Director, and his staff. Months of careful preparation and skilled craftsmanship have been spent in the preparation of this exhibit, which displays M.I.T.'s history on a time scale from its inception, the building of the Rogers Building, through the move to Cambridge, where the Class of 1917 was the first to graduate.

On May 30, M.I.T. formally acknowledged acceptance of this gift from the Class of 1917, at a luncheon given in the McLaurin Room, to the Class officers and other class members, who live in the Boston area, and were physically able to attend. Those present were: Jeannette and **Stan Dunning**, Mildred and **Stanley Lane**, **Ray Stevens**, Rom and **Phil Cristal**, and honorary members: Jay and Kay Stratton, and Don and Phyllis Severence. Stan Dunning, Class President, spoke and lauded the excellence of the display and its significance to everyone of the M.I.T. family.

Jeannette and **Stan Dunning** moved on June 6 to their new home at the Havenwood Retirement Community. Their new address is: 33 Christian Ave., Box 218, Concord, N.H. 03301. Stan reports they are delighted with their new home.

Ed Payne and **Ray Stevens** were the only '17ers at the "Technology Day for Alumni" luncheon this year. Ray says they were honored by sitting at one of the front tables, but it made them feel a bit old.

We regret to report the death of **Harold E. Hebenstreit** at his home in Fullerton, Calif. He is survived by his wife and stepson, Dr. Albert E. Hayes, Jr., '42.

The death of **Harry A. Wansker** in Sarasota, Fla. on June 1, has been reported by Parke D. Appel, '22. He leaves his wife, Dorothy C. Wansker, two daughters, and five grandchildren. He was very active in the M.I.T. Club of Southwest Florida.

A recent letter to "Friends of M.I.T. Sailing" from Sailing Master, Hatch Brown, brings satisfaction to the classmates of **Jack Wood**. Jack organized sailing at M.I.T. There are today about 1300 sailing members. In June, the Intercollegiate Sailing Championships returned to the Charles River, where for many years, all college championships were held and where intercollegiate racing was initiated. Jack Wood recently underwent minor surgery, but is still sailing out in San Diego.

Again I must report the death of another classmate, **Samuel F. Chalfin**, who died on May 5, 1980. His home was in Marblehead, Mass., and prior to his retirement in 1961, he was a vice president of American Machine and Foundry Co. He served that company for 35 years. He is survived by his wife, Esther W. Chalfin, and a daughter.

Doris and **Bill Hunter** spent the first week in June in Wisconsin, attending the graduation events at St. Johns Military Academy, from which their grandson, and Bill's namesake, graduated. While out there, they visited friends and relatives in Milwaukee and the Chicago area. — **William B. Hunter**, Secretary, Prospect North, Apt. C-8, 633 Prospect Ave., West Hartfort, CT 06105

18

Serendipity is the name of the game this month. You will see this in the following excerpts. **Packy McFarland** wrote to **Herb Larner**:

"I went with Atlas Powder Co. in 1920 and retired in 1962. My travels took me to all 48 states at that time and to some very remote locations wherever explosives were used. I saw many of the big dams under contruction such as Grand Coulee and others on the Columbia River. . . . This week we hope to celebrate our 55th wedding anniversary. We have two married daughters and seven grandchildren. I try to keep in shape with an acre of garden and a fairsized lawn to maintain. I notice each spring it takes a little longer to get into condition."

Herb reports about himself:

"I live in an apartment and have for the last 30 years, and I want no part of condominiums or cooperatives.

It seems to me that you are living just about the ideal life: walking, playing squash, going to business, and participating in the affairs of M.I.T., and you are doing an outstanding job as class secretary. Only a dedicated fellow like you could handle it. You are to be congratulated.

"I wish I could be with you on Alumni Day, but I can't. Mildred's innumerable grandchildren are always having birthdays, weddings, etc., and early June will see us in Pennsylvania, and then on to Woodstock, Vt."

I had the pleasure of a telephone call from faithful **John Abrams** from California. He had make a good recovery from a recent illness. He was getting ready to take a trip to Florida to visit two new grandchildren. I am sure he will return to California to do his bit to improve conservation of energy and resources.

A March 17 clipping from the *Clinton Daily Item* records the death of **Ralph Mahoney** on March 16 in Danvers, Mass. Mr. Mahoney owned and operated the Sterling Inn for many years before retiring. He leaves his wife Rose, a brother and a sister.

A delayed new item records the passing of **Leslie A. Stewart** on July 5, 1979. **Marshall Sanders** of Wilmington, Del., died on March 22, 1980.

A suggestion — how about writing a classmate crossing paths in the near and not so near past? — **Max Seltzer**, Secretary, 60 Longwood Ave., Brookline, MA, 02146, and **Leonard Levine**, Assistant Secretary, 519 Washington St., Brookline, MA 02146

20

At this writing the 60th reunion is history. We can count it as successful in every way, except perhaps the weather. Twenty-five classmates and 17 wives — a goodly turnout. Those present: Betty and **Norrie Albert**, Theresa and **Larry Allen**, Mina and **Perk Bugbee**, Betty and **Alan Burke**, Pat and **Buzz Burroughs**, Ann and **Bink Carleton**, Marion and **Warren Chaffin**, Mary and **Buck Clark**, **Ed Cousins**, **George Des Marias**, Barbara and **Bill Dewey**, Gladys and **Foster Doane**, Evangeline and **Count Dumas**, **Al Fraser**, Hannah and **Harry Kahn**, Kay and **Frank Maconi**, Mary and **Henry Massey**, **Jack Nolen**, **Ed Ryer**, Florence and **Lee Thomas**, **Phil Wait**, **Elbridge Wason**, **George Wilson**, and, of course, Amy and **Harold Bugbee**.

The Pre-Pops buffet and Pops concert were voted the best ever, and the Technology Day activities left nothing to be desired. Our class dinner was enhanced by distinguished guests, Harl Aldrich, '47, new president of the Alumni Association, and his charming wife. In a note to Norrie, Harl writes, "The vitality of your class and your continued support of the Institute are exemplary." Good word — that "vitality!" The class history was distributed at the dinner; if, by any chance, you haven't received a copy, let me know and I'll mail you one of the few copies left.

Next day, we set out by bus for the famed Quincy Market. Believe it or not, our bus driver got lost; so we were given an extra sightseeing bonus of scenic Somerville plus a brief glimpse of marvelous Medford. However, we finally landed. The steady rain and Saturday crowds kept everybody indoors so it was impossible to stick together but we all managed to find ourselves a good lunch and get back to M.I.T. in plenty of time for our banquet at the plush Hyatt Regency adjoining the campus. Our home-grown speakers consisted of George Wilson, who told us about the Quincy retirement set-up; Bink Carleton, who talked of his experiences on a container ship voyage but

who earned some boos by telling us that the age limit was a mere 79; Hannah and Harry Kahn, who told of their trip to Iran to set up a ceramic industry there, and Foster Doane, who talked of his experiences in the Orient as a visitor to pulp and paper mills. All very entertaining and enlightening.

Buzz Burroughs tells us that the story which appeared in our class news for January 1977, entitled "The Fun Begins at 80," was picked up by "Dear Abby" in her newspaper column under the heading "Just say you're 80, and you've got it made." You .ay recall that the late **Bob Sumwalt** of Columbia, S.C., sent us this amusing story. Buzz made a few copies, so if you want one write him at: Chipmunk Farm, Topsfield, MA 01983.

Harold Baker, who received his Master's degree in 1920, writes that he was married last year to Ruth Buckstaff (Earlham College, 1920). Their winter home is 1425 U.S. 19 South, 31-E, Clearwater, FL 33516.

News has just been received of the death of **Ed Rich** of Wellfleet, Mass., on December 13, 1979. From the sister of **John Perkins** of New Britain, Conn., I have further information about John, who died on April 13 of this year. John had a distinguished career as an engineer, photographer, and free-lance writer using the pen name Jack Perkins. He is survived by two sons and seven grandchildren plus a great-granddaughter. His sister suggests that memorial contributions in his memory may be made to M.I.T.

Good news from Gertrude and **Jim Wolfson** who were sorely missed at reunion: They have located a new apartment in Hallandale, Fla., at 400 Golden Isles Drive, Apt. 8 — **Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, MA 01890

21 60th Reunion

Alumni Day luncheon at M.I.T. on June 6 brought forth Helen and **Bob Miller**, **Arnold Rood**, **Don Morse**, **S. Paul Johnston** and **Irving Jakobsen**. Don Morse says plans for our 60th Reunion in June 1981 are nearly complete and a letter will go out to the Class this fall. So, keep well and plan to attend a glorious 60th next June.

Bob Miller phoned on the way to their summer cottage on Cape Cod, and a subsequent letter reported an overnight stop at Emma and **Al Lloyd**'s in Westerly, R.I. The Lloyds had just returned from a two-week visit with their daughter Barbara in Switzerland. Bob phoned **Helen St. Laurent**; she was planning to go to Center Lovell, Maine. A phone call to Marion (Mrs. **George Chutter**) found her in good health and planning a trip to relatives in Vermont. Bob and Helen are planning a trip up the Maine coast and over into Vermont when they leave the Cape.

The following summary of the career of **S. Paul Johnston** deserves to be published in full, but I can only hit the high spots in these notes.

Paul Johnston, director of the National Air and Space Museum of the Smithsonian Institution from 1964 to 1969 was associated with aviation, space and allied activities ever since his graduation from M.I.T. His first job was with Alcoa where he became assistant to the chief mechanical engineer. In 1929 he went to work for a former professor, Edward P. Warner, editor of *Aviation* magazine. In 1931 *Avaition Handbook*, a technical reference book for aircraft engineers, was published by McGraw-Hill under joint authorship of Warner and Johnston. Paul succeeded Warner as editor of *Aviation* in 1935. He made extensive surveys of the aircraft industry in Europe and published his findings in many journals, including *Technology Review*, the *Christian Science Monitor*, and the *Saturday Evening Post*.

At the end of 1939, Paul became coordinator of research for the National Advisory Committee for Aeronautics in Washington, D.C. Following President Roosevelt's announcement of a 50,000 plane program, Paul participated in forming the wartime Aircraft Resources Control Office. In late 1942 with the approval of the Navy, he was appointed manager of Curtiss-Wright's Washington office. During the period 1939-44, he wrote four full length books on aviation and contributed numerous articles to the technical press and the Encyclopedia Britannica.

Three M.I.T./Wheelock couples celebrated the 60th anniversary of Ruth Mudge Wilson (Wheelock, '17) and Irving H. Wilson, '20 (above center) on July 3 in Lynnfield, Mass. At right are Ocy Hoyt Breed (Wheelock, '18) and C.A. ("Al") Breed, '20. Also celebrating were David R. Wilson, '73 (left), grandson of Ruth and Irving Wilson, and his wife, Michele Miller Wilson (Wheelock, '70). David will receive his Ph.D. from M.I.T. this year and is the third generation of his family not only to attend M.I.T. but to belong to Lambda Chi Alpha. David's father, Robert E. Wilson, '45 (not shown) lives in Bala Cynwyd, Penn.

In December, 1944, as a commander in the Navy, he was transferred to the U.S. Strategic Bombing Survey in London as director of operations of the aircraft division in the ETO. After World War II, Paul was promoted to captain and was awarded the Legion of Merit.

Other positions held include chief executive officer of the Institute of the Aeronautical Sciences and executive secretary of the American Institute of Aeronautics and Astronautics. Paul has had many honors and tributes paid to him. He has continued in consulting work since 1969, both in federal and private projects. He loves sailing on Chesapeake Bay. We salute a distinguished classmate!

A letter from Dorothy (Mrs. **Joseph Wenick**) says, "I've been here in Florida since November 18 and now realize what a wise move I made. Our house and grounds in New Jersey required too much care. Broward Community College is across the road from my place and I have been taking courses and attending concerts. I will be leaving for Washington, Baltimore, and Pennsylvania on June 12 to visit my sons and niece. Possibly I'll get up to New Jersey and will phone you."

Maxine and **Cac Clarke** and Betty and **Sumner Hayward** attended the annual dinner meeting of the M.I.T. Club of Northern New Jersey in May. The Clarkes recently returned from a Caribbean cruise. Maxine had casts on both arms, the results of a fall at one of the cruise stops, but she appeared to be doing fine and was in good spirits.

Alumni Fund envelopes brought in a couple of tidbits. **Dave Woodbury** writes, "I have retired from journalism just in time for my 84th birthday." . . . **Glenn Easton** says, "Still spend eight months at Satellite Beach, Fla., from October to June. Then I go China Lake, Maine, for the summer months."

Helier Rodriguez called **Josh Crosby** to invite him to an M.I.T. club meeting to hear Dr. Edgerton talk on stroboscopy. Helier and Graciela both had grippe in February and hadn't completely recovered. Because of this, they cancelled plans to attend the annual Mexican Fiesta and may give up a projected trip to Europe this summer.

Helier also informed me of the death of **Elmer W. Campbell** of Seminole, Fla., on March 24, 1980. Elmer was a graduate of Colby College, M.I.T., University of Michigan, and Harvard School of Public Health where he received his doctorate. He served as state director, Division of Sanitary Engineering, for the state of Maine from

1923 to 1965. He served in both World Wars and was past commander of the Military Order of the Retreads. The sympathy of the class goes out to his family. — **Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, NJ 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, FL 33579; **Samuel E. Lunden**, Assistant Secretary, 606 S. Olive St., No. 701, Los Angeles, CA 90014

22

Our most important news is from June's Alumni Day at M.I.T. Those attending were: **C. Hall Baker**, Cape Elizabeth; **C. Randolph Myer**, Wilton, N.H. **Marjorie Pierce**, Weston; **Winthrop F. Potter**, Lexington; **Fearing Pratt**, Hingham; **Walter Saunders**, Cape Elizabeth; **Robert Tonon**, Cambridge; **Oscar Horovitz**, Newton; **Whitworth Ferguson**, Buffalo, represented by Donald Ferguson, '59.

Marjorie Pierce reports that she is a specialty architect for houses and alterations to residences. . . . **Oscar Horovitz** is playing a very good game of golf and asked us all to stop in and enjoy his hospitality at Pompano Beach. . . . **Randy Myer** is thrilled by his new great-granddaughter. He continues to manufacture wood products in New Hampshire. His son is John Myer '52, a professor of architecture. . . . **Win Potter** has been walking up mountains in New England lake district and will get his exercise in Austria this year with his wife, Tony. Tony is retiring as librarian from Arlington Senior High School to increase available time for travel. . . . **Walt Saunders** enjoys living in Maine and has reported the remarkable coincidence of a book review of fiction signed Paul Gray. Your secretary has acknowledged to Walt that mistakes are made by misinterpretation at times! . . . **C. Hall Baker** works six days a week checking apartments and collecting rent. His daughter lives nearby. . . . **Fearing Pratt** is a charter member of his ski club and enjoys working out at Pinkham Notch during the right kind of weather.

We were sorry not to be able to attend the luncheon meeting for Classes 1918-28 at M.I.T. Endicott House to hear Dr. Walter A. Rosenblith share his observations of the development of M.I.T. over the past 50 years. We hope to receive a report from others.

Marian and **Ray Stone** have sent a beautiful picture postcard of Exumas, Bahamas, as they sail northward on the intercoastal waterways to see their daughter, Carol, and for a visit at Sharon near Boston. They also went to Storrs, Conn., to visit their son, Frank and family. Next they traveled to their 55th Reunion at St. Lawrence University in Canton, N.Y. Later they will fly back to their home in Tampa.

Fran and **Harvey E. Brown** report from Montclair that they will open their summer home on the Jersey shore early in May for outdoor activities. Harvey reports that his book, *Zinc Oxide Properties and Applications*, recently won "Best of Show" for top award of the International Publications Competition sponsored by the Society for Technical Communications. His book was one of 370 in the competition and lists over 5,000 references to zinc oxide in research papers published over the past 20 years. Harvey has been engaged as a chemical consultant to several companies since retiring. He states, "As industrial research laboratories continue to spawn new and better products, their marketing will pose many problems" — which he hopes to continue solving.

A happy news item in Fort Lauderdale announces that **Martha Eisman Munzer** and Issac Corkland were reunited recently to resume a courtship interrupted by World War I. They were married in a Pompano Beach synagogue and have taken a month-long honeymoon in Israel. They say part of the reason they are getting married is to make it easier to register in hotels when they travel. They say, "our life is only beginning," following the title of her eighth book, *It Might As Well Be Spring*.

We are sorry to report the loss of General **William M. Hoge** of Easten, Kans., in October, 1979, and **Vesper Schlenker** of Gaston, Ind. Our sympathy goes to their families.

Item: This summer weather in Buffalo with its cooling breezes from Lake Erie and its sunshine beaming across New York to Canada is beyond compare. Come on and join us. — **Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, NY 14203; **Oscar Horovitz**, Assistant Secretary, 31 Montrose St., Newton, MA 14203

23

Revisions of the 1973 constitution have been approved by class vote and **President Goetchius** has declared it in force. Results of the voting, April 19 through May 9, were as follows:

Number of ballots mailed	379
"Yes" votes	164
"No" votes	0
Returned "undeilverable as addressed"	6
Reported deceased	7
Reported mentally incapacitated	1
No response	201

Class members will be sent a copy of the new document by the Secretary-Treasurer upon request.

Obituaries for the members reported deceased have already appeared in the notes. Since May 9, seven additional "yes" votes have been received, and the ballot package sent to **William C. Merrill** at E. Elmhurst, N.Y. was marked "deceased." We have no details. William graduated with our class in chemical engineering and became a chartered life underwriter with Penn Mutual Life Insurance Co. Upon retirement, he became a volunteer worker in the Jewish Home and Hospital for the Aged in New York City.

Ida M. Green, wife of **Cecil H. Green**, was made an honorary alumna at the annual luncheon on June 6. **Horatio Bond**, Kay and **Julius Stratton**, and your secretary-treasurer were the only representatives at the 1923 table. In addition to their many gifts to various educational institutions, the Greens have recently given the Cecil H. Green Library to Stanford.

A card from **Al Pyle** postmarked Oslo indicates that he and entourage continued their travel during the spring to visit his daughter, whose husband lectures on linguistics in Oslo and Bergen. Al hoped to visit some hydroelectric stations, and enthused about seeing trolly cars still running.

In the June/July notes, the name of the firm with which **Fred Smith** was associated should have read "Brockway-Smith-Haigh-Lovell Co." — **Richard H. Frazier**, Secretary-Treasurer, 7 Summit Ave., Winchester, MA 01890

24

Eleanore and **Bill MacCallum** were together victims of carbon monoxide on June 13, 1980, at their home in Cotuit on Cape Cod. Your scribe and several solicitous classmates had visited Bill during his several recent sessions at Massachusetts General Hospital, and we will all miss his characteristic jovial and erudite conversations. A memorial service was very well attended including **Phil Blanchard**, **Don Moore**, Helen and **Dick Shea**. Although he spent only two years with us after study at Haverford College, Bill was a very loyal Institute supporter. He gained his S.B. in Course XV and shortly after graduation anticipated the future in talking pictures, particularly educational films. He completed his career as an executive of Modern Learning Aids. His avid interest in M.I.T. is obvious: he was president of the Philadelphia and Los Angeles clubs, organizer of the M.I.T. Club of Cape Cod, director of the Alumni Association, and recipient of the Bronze Beaver Award for distinguished Alumni service. In 1945, Bill also received an award for service in the War Finance Branch of the U.S. Treasury. He was a member of several educational associations and former vice president of the American Film Science Association. The officers and Class extend their sympathy to his daughter, Alexandra.

On May 6th, **Ray Lehrer** hosted **Frank Shaw**, **Herb Stewart**, **Don Moore**, and your amanuensis for luncheon at the Algonquin Club, Boston. Chief discussion related to a proposed mini-reunion in June 1981, at the Inn in Woodstock, Vermont, advocated by **Ed Moll** as deluxe accomodations. The same subject was analyzed in detail by **Phil Blanchard** and cohorts July 10th at the Faculty Club. No reflection on Ray's luncheon, but shortly thereafter, Frank went into Massachusetts General Hospital for an open-heart operation. He is making slow progress and soon will transfer to a rehabilitation unit for therapy. He retains his old sense of humor.

George W. Glennie passed away in Andover, Mass., on June 8; he had been ill for four months but appeared to be making a good recovery. George earned an S.B. in mechanical engineering and spent his entire career in some phase of the insurance business, retiring in 1962 from Commercial Union, Boston, as superintendent of the Boiler and Machinery Department. George was an avid golfer, past president of the Andover Historical Society, member of the Lawrence Camera Club, A.S.M.E., and Society of Military Engineers.

Edward C. Keyworth died in Florida on August 20, 1978, as reported by his wife. He was registered in course XV and in 1949 was listed with Collier-Keyworth Co., Gardner, Mass.

Edward S. Sheiry passed on in Menlo Park Calif., on March 18, 1980, according to a note from his daughter, Barbara Ely. Ed earned three degrees — S.B., S.M. and Civil Engineer from M.I.T. He had foreign experience as Professor of Civil Engineering and head of the department at Robert College, Istanbul, Turkey, and as chief engineer for the Technical Division of Cia Vale do Rio Doce, Rio de Janiero, Brazil. Among other occupations, he was head of the Civil Engineering Department at Cooper Union, New York. His home was in Bronxville, N.Y., for a number of years and he was a Mason, a member of A.S.C.E., the M.I.T. Alumni Center of New York, and the American Legion. He was the associate editor and contributor to the *General Engineering Handbook* (McGraw Hill).

Technology Day was attended by Professor **Irwin Sizer** (Honorary '24), **Herb Stewart**, **Don Fife**, **Don Moore**, **Stuart Morgan**, **Ed Moll**, **Gordon Billard**, and **Russ Ambach**. The latter two inspected the marvelous, nearly completed indoor athletic complex with Professor Ross ("Jim") Smith, Athletic Director, who retired as of July 1 after bringing that project to fruition. — **Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, MA 02146; **Herbert R. Stewart**, Co-secretary, 8 Pilgrim Rd., Waban, MA 02168

25

Our 55th Reunion was attended by thirty classmates plus twenty family members. We joined alumni from all classes on Technology Day, which was a beautiful June day, and everyone seemed to have an enjoyable time despite the fact that the weather failed to cooperate on Saturday, June 7, when the visit to Endicott House in Dedham, Mass., was marred by rain.

There were two class dinners: on Friday night, June 6, we gathered at the Bush Room, now adjacent to the Alumni Association headquarters, and Saturday night, June 7, we were at the Historical Collections rooms where everyone enjoyed seeing the excellent collection of M.I.T. memorabilia which had been gathered in recent years. After each dinner **Milt Salzman** led our group in singing favorite songs and provided solos as well. We found that the class has two stand up comedians namely **Arthur Odegard** and **Henry Sachs** who provided entertainment. Those in attendance were: Freda and **Harrison Browning**, Lucinda and **Gates Burrows**, Katherine and **Alan Crowell**, Evelyn and **Leroy (Doc) Foster**, **Franklin Fricker**, **Willard Gardiner**, Eleanor and **Fred Greer**, **Arthur (Gus) Hall**, **William Herbert**, Gertrude and **Eugene Hermann**, **Jim Howard**, **Kamy Kametani** from Japan , Wei and **Yu Ku** with daughter Weiman, Adele and **Ed Kussmaul**, Grace and **Stanley Lane**, **Ed McLaughlin**, **Frank Mulcahy**, Ruth and **Arthur Odegard**, **Ben Oxnard** and his mother-in-law Mildred Hitch, Ruby and **Rufus**

Palmer, Phoebe and **Wilder Perkins**, **Richard (Tom) Price**, Constance and **Goeffrey Roberts** from England, Beatrice and **Henry Sachs**, **Milt Salzman**, Verna and **Arthur Sharp**, Elinor and **Sam Spiker**, **George Washington**, **William (Rick) Wheeler**, and Margaret and **Courtenay Worthington**.

Following luncheon at the Endicott House, Dean Irwin Sizer gave an interesting talk covering some of the present activities at M.I.T. Also, there was a short business meeting for the election of class officers. The following slate was presented and elected: president, Edwin E. Kussmaul; vice-presidents, Jim Howard and Courtenay Worthington; treasurer, Will Gardiner; and secretary, yours truly. Harrison Browning agreed to continue as estate secretary and Jim Howard will continue as class agent until a new one is appointed.

Several classmates who had hoped to attend the reunion wrote to tell us they couldn't make it. President **Garvin Drew** and Lillian were sorely missed. Chink has been hospitalized twice during the past year and is now in a nursing home in Laguna Beach, Calif. . . . **Fred Somer** has to have daily medication as a surgical diabetic and requires tests which are better done at home. . . . **Bill Asbury** has had a pacemaker installed rather recently and felt the trip might prove too much for him. . . . **Jesse Maury** found he had business obligations which could not be avoided. . . . **Al Golemon** had a golden wedding anniversary on May 4 and left on a second honeymoon cruise shortly thereafter.

Don Taber sent his regrets and enclosed a news article which will certainly be of interest to classmates. It reads as follows: "The Donald R. Taber Gallery of Fine Arts, a new room at the Holyoke (Mass.) Public Library, will be opened Sunday, May 18, 1980 during special ceremonies honoring the man for whom it is named. Taber, of Lindor Heights, former president and chairman of the board of American Pad and Paper Co., now AmPad, will be honored during a reception at the library. A former president of the Holyoke Public Library and Museum, Taber will be presented a scroll by libary president Edmund Gill Woods, Jr., in honor of his years of work for the library. According to Woods, Taber's dedication to the library and museum go far beyond the years of his formal associations as an officer. 'Mr. Taber has held every conceivable position with the library and has constantly worked for both the library and museum,' Woods said. 'His own donations have been generous and he has been generous with his time in seeking donations for the library and the museum.' Tabor received the William G. Dwight Distinguished Service Award in 1967. His activities in business and civic committees of Holyoke have covered more than half a century. He retired as president of AmPad in 1971, and as chairman of the board in 1974, after more than 45 years with the company." Don adds that the gallery has a small but choice collection worth a visit by anyone coming to the Holyoke area.

The National Academy of Sciences announced its award in aeronautical engineering (with a $4,000 honorarium) to **James S. McDonnell**, chairman, McDonnell Douglas Corp., St. Louis, for "distinguished and pioneering contributions in engineering design and development of advanced military and commercial aircraft."

Formerly of Baton Rouge, La., **G. Monroe Patch** now lives at 2153 Pueblo Circle, Sarasota, Fla.

It is with sorrow that I must report the death of three classmates: **Wallace J. Squire** of Natick, Mass., January 21, 1979; **F. Payson Hammond** in Clearwater, Fla., February 10, 1980; and **Samuel H. Tinsley** in Leesburg, Fla., April 2, 1980. — **F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

26 55th Reunion

Honors continue to be awarded to our distinguished classmates nationally and internationally. The first was the announcement May 15 from the National Science Foundation: "**Dr. James R. Killian, Jr.**, the country's first full-time presidential adviser for science and an educator whose service to the nation's scientific and technological welfare spans more than half a century, has been selected as the first recipient of the National Science Board Vannevar Bush Award. Dr. Norman Hackerman, Chairman of the NSB, announced the award would be presented at an annual dinner of the Board at the Department of State as one of the events celebrating the 30th anniversary of the Foundation. Dr. Killian will be presented with a special medal struck for the occasion and a citation."

Doc Draper will take a nine-week world tour, including a visit to the People's Republic of China, beginning July 28. He will meet in Bombay with an old friend, Dr. **Shantanu Kirloskar**, now a leading industrialist of India. Doc's visit to China is at the invitation of China's Deputy Director of the International Department of the Association, the Scientific and Technological Commission. In addition to giving a series of lectures on various subjects including inertial guidance, he will travel to several cities, including Xian, Wushih, Shanghai, Hangchou, and Guilin. This part of the trip will be hosted by the Chinese government and will last 38 days. Doc's trip will conclude with a visit to Tokyo, where he will attend the International Academy of Astronautics meeting, which occurs at the same time as the XXXI Congress of the International Astronautical Federation. Doc is the President of the Academy.

We just recently received a note from **Don Cunningham** with — lo and behold — a letter from Shantanu in which he refers to Doc's impending visit. Some excerpts: "I must say how much I enjoyed meeting friends at the reunion at Hotel Belmont and I would very much like to meet as many friends as possible at the 55th reunion. . . . There is a great chance of us being in Boston at that time, because one of my grandsons, Vikram Kirloskar, is expected to graduate in 1981 and we very much hope to be at M.I.T. for his graduation."

"I hope this finds you in good health. Last October, I was operated on for a coronary bypass surgery at the Mayo Clinic, Rochester, Minn., and am now back to my normal health with a better heart."

Pink Salmon is retiring and moving to Pennsylvania in July, so I will try to get together with him and **Bob Dawes** before he leaves to discuss 55th reunion plans.

Speaking of peripatetic classmates, we heard recently from **Whitney Ashbridge**, who is building a new house in Belen, New Mexico (mail address: P.O. Box 988, Belen 87002.) Referring to our crossing and near-crossing paths in recent years he writes: "Between my ten years in South America, 5½ years in the Army during World War II at Los Alamos and the Pacific, and a cruise to Japan, Taiwan, Hong Kong, a couple of trips to Europe, two to Southern Africa, Egypt, etc., South America as far south as Rio on the East coast and Ecuador on the West, it's a wonder we didn't meet somewhere along the way!"

A brief note from **Helmut Geyer**: "It's just 52 years this week since I left the Tidewater Field Station of M.I.T.'s Graduate School of Fuel and Gas Engineering. I retired in '72 for some medical attention, was recalled New Year's day, '77 and am now commuting 120 miles a day, three days a week, to my office in Los Angeles. I am spending most of my time translating commercial, legal correspondence, technical and engineering articles from German to English and vice versa, dealing with 76 countries around the globe."

From **Ed Lame**: "Have retired for the third and last time at 75. Keeping busy at local Arboretum and in Red Cross, not to mention at house chores, bread making and gardening.". . . From **George Bates**: "Retired — status quo. Would like to send greetings to the fellows I played ball with — 6a.m., 1925-6 when the space between the main building and Walker Memorial was a playing field."

And now we regret to tell you of several death notices we have received since our most recent notes: In December, 1979, **Donald Dodge** died unexectedly while on a visit with his family in Blue Hill, Me. He is survived by his wife, Jan (Parker) Dodge, of Charlotte, N.C.; one son, Peter, of Blue Hill, one daughter, Mrs. Margaret Kohler, of Lloyd Harbor, N.Y., and four grandchildren.

In February **Elmer C. Ingraham** died at 82. He had spent his most recent professional years in the M.I.T. research department. He left his wife, the former Francena Little, two daughters, a sister, six grandchildren and four great-grandchildren.

In January, 1980, **Samuel W. Brooks** died, leaving his widow, Irene, at 26 Young Rd., Falmouth, Mass. 02540.

In April, Melvin C. Dow died. He lived at 850 Victor Herbert Dr., Largo, Fla. 33541.

The Class extends its sympathy to the widows and we hope to do so in person to those who will find it possible to meet with us at our 55th in Chatham. — **William Meehan**, Acting Secretary, 191 Dorset Rd., Waban, MA 02168; (617) 527-2995

27

Our reunion chairman **Dike Arnold** has gained recognition in the sophisticated sport of English Croquet. He was featured in the Boston *Herald* spread on the game as played in Boston Common last May; sponsored by the U.S. Croquet Association. No ordinary hit or miss competition, this, a very complicated set of rules is followed. Many of us who attended our reunions at Bald Peake will remember Dike's coaching in our croquet contest. The real problem for him now is that he must play matches that conflict with his golf to maintain his standing.

Harold E. (Hal) Edgerton is off this summer on another fishing expedition — this time for a German U-Boat sunk by our dive bombers in 180 ft. off Cape Hatteras. How does he know its there? He found the only survivor — the Captain who managed to make his way out the escape hatch. Hal has also contacted the pilot of the bomber and obtained a general idea of the location. So maybe after 10,000 pictures along the contour line, Hal will find some other 35 year old German beer. Good luck.

Ed Mott, who retired as Underwater Sound Instruments engineer with Bell Labs in 1969, reports that he has bought an electric car, "the new gas-less car of the future". From his picture is looks like an overgrown golf cart and he strongly recommends it for community travel for those able to service and charge it. He is active in three senior citizens groups and with Planned Parenthood in his town.

We regret having to report deaths of several of our loyal classmates:

Charles C. Smith died on January 7 from a heart attack at his home in Green Valley, Ariz. He is survived by his wife Eleanor and his two sons Charles and Christen. He was employed at General Electric from 1930 to World War II when, with the rank of Colonel in the Engineers, he was assigned to manage the 14th Port of Embarkation in Southampton, England. In 1950 he rejoined G.E. in Louisville. In 1964 he purchased Harvey P. Bertram Co., Amelia, Ohio, and in 1969 constructed a new larger plant renamed Industrial Air, Inc. of which he was president until his retirement in 1972. Since then he and his wife travelled extensively; his latest trip to Alaska was reported in our notes. Charlie pursued an active and accomplished career combining business with distinguished military service.

Dr. **Irving D. Thrasher**, who died Nov. 21, 1979, graduated with a degree in Life Sciences and was a physician and surgeon throughout his life. He resided at 1150 N. State St., Chicago.

Frank L. Meyer, who died last winter, was president of Meyer Furnace Co. Peoria, Ill. Frank led an active and distinguished career in the heating and air-conditioning industry. Officer or director of several businesses in his home area, he participated as director and president of the National Warm Air Heating and Air Conditioning Assoc., and was chairman of its Research Council. Other societies he belonged to included Gas Appliances Manufacturing Association, American Gas Association, and life member of A.S.H.R.A.E. and A.S.M.E. Frank was a loyal alumnus attending most of our reunions. His two sons will carry on the business.

Nathan L. Mintz, who died on Dec. 3, 1979, was

a patent examiner at the U.S. Patent Office most of his life. He was expert in the game of table tennis. Inventor of a new game called "Kickgolf", he had the idea to start a non-profit corporation to promote the game with all proceeds going to M.I.T. and Israel. Nathan enjoyed our 15th, 45th, and 50th reunions.

Albert C. Buffum died on Dec. 9, 1979. Active in civic organizations, he was president of Elkhardt, Ind., Redevelopment Commission and the Advisory Council of Elkhardt Careers Center. He was an ardent fisherman and traveler to Alaska, Canada, Baffin Island, Newfoundland and many other countries.

Richard E. (Steam) Harrison, who died on Feb. 27, lived on Long Boat Key, Fla. He was construction engineer for New England with Getty Oil Co. for 20 years until retiring in 1967. He was an eager ham radio operator and enjoyed talking to his classmates on the air. He attended our 40th, 45th, and 50th reunions. Steam is survived by his wife Kay and daughter Sally, and many friends in his class.

Your secretary apologizes for not reporting in the last two issues. Last Feb. we enjoyed a Florida visit when the report was due, and the April notice from the *Review* was lost in the mail. Pretty weak excuses. — **Joseph C. Burley**, Secretary Protem, 5 Hutchinson St. Milton, MA 02187

28

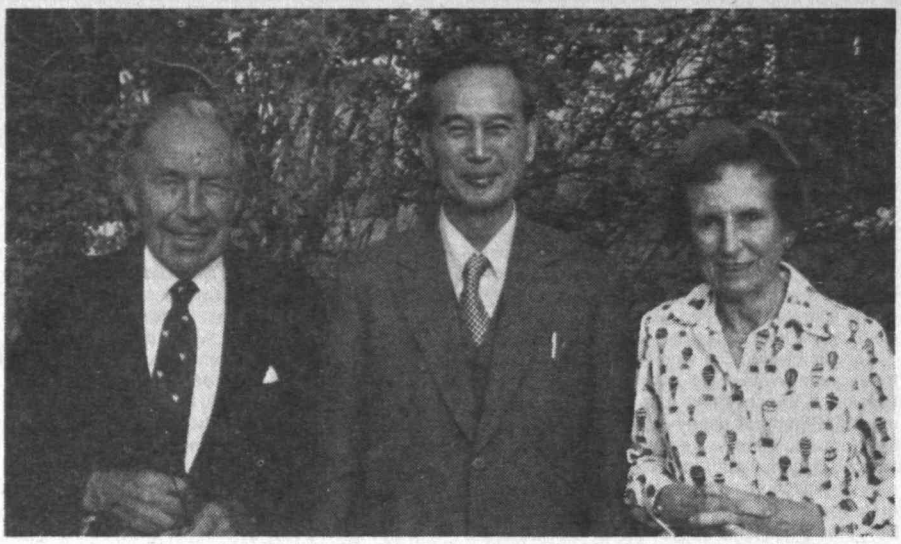
Our class was well reported at the Technology Day events in Cambridge on June 5 and 6. Those who were in attendance are listed here from memory — our apologies if we have omitted anyone: **Maurice Beren**, Frannie and **Jim Donovan**, **Newt Foster**, Janet and **Fred Lewis**, Mary Nichols, Florence and **Walter Smith**, **Frank Taylor**, Ann and **Will Tibbetts**, **Hermon Swartz**, Ruth and **Abe Woolf**. Both Marjorie (Mrs. **John A.**) **Cavalho** and Jo (Mrs. **Edward M.**) **Shiepe** came to join those of us who attended the memorial services for recently deceased alumni. Then, happily, they stayed for luncheon and the Friday noon exercises in Rockwell Cage.

We received gracious notes later from Marjorie and Jo. Each expressed the pleasure she had experienced in joining with others of the '28 group. For this we are well pleased since we always try to encourage spouse participation in Class events, and widows are most welcome to continue their association with the Class.

Olive and **Newt Foster** wrote to tell of their travels in the year past. In spite of severe gasoline shortages they were able to take their 22-foot travel trailer for their usual winter trip to Florida, then to Massachusetts for a family gathering in June, 1979, and back to their camp at Estling Lake, N.J., for the summer. In October, they attended the Alumni Officers' Conference at M.I.T. Olive then joined a group of friends for a three-week rug and textile tour of India. In December Newt and Olive helped to put on a special oriental rug show at the Metropolitan Museum of Art in New York. Finally, they drove back to Florida to arrive at their campsite in time for a big Christmas dinner with about 80 fellow campers.

During a recent trip to the West, Frannie and **Jim Donovan** stopped in Sun City, Arizona, and, while there, visited with the **Lawrence Armstrongs**. Jim says the Armstrongs are planning to leave Sun City and will move back to their earlier home in Three Rivers, Michigan. . . . A short note from **Hy Weinberg** contains the philosophical statement that at our age the time to do anything is right now. Hy's only further concern for the moment is that he will have to endure the summer heat until September. Otherwise all seems to be well with him.

We regret to report that **Robert T. Wise** died on June 14, 1979. Bob graduated in Course VI, electrical engineering, then studied at Harvard University for his M.B.A. degree. For most of his professional life he was with the consulting firm of Booz, Allen and Hamilton, Inc., in Chicago and became vice president. To Bob's family we extend our heartfelt sympathy. — **Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890



Chung-Foy Yee, '29, of Canton, China, visited M.I.T. this spring for the first time since graduation. After presenting a paper at the International Metallurgical Conference in Detroit, he came to Boston where he had dinner with Doris and Bill Baumrucker, '29, in their Marblehead home.

29

Emmette F. Izard was the recipient of a special recognition award by Mississippi Academy of Science during its 50th anniversary meeting. The *Copia County Courier* states: " . . . He started earning commendations at a very early age and has continued through his 76 years, making contributions to his chosen field of chemistry, in church work, in scouting and many other fields. His work in the polymer chemistry field, particularly his work with films and fibers, which resulted in the development of such products as Dacron, Mylar polyester film, and Cromar polyester photographic film base, has touched the lives of every American and most industries."

Harold M. Weddle of San Diego, Calif., writes, " . . . My lifestyle has changed a little, since I had open heart surgery. I play a little golf, do a little gardening, read and take two 30-minute walks every day. With a proper diet, I have lost about 40 pounds which makes me feel great." . . . **Anthony Standen** of South Kent, Conn., has been a member of the Connecticut League of Women Voters and is the resource person for the Committee on Energy. He also publishes books on various subjects, including one on anti-astrology called *Forget Your Sun Sign*. . . . **Thomas W. McCue** of Newton Hylands, Mass., is still active in selling steel and other metals, representing a number of firms. He is also taking a course in economics at Boston University and plans to add a couple of language courses, such as Spanish and Portugese. He sends his regards to all.

Arthur J. Bearse of Gloucester, Mass. and Charlote Harbor, Fla., writes, " . . . This has been a good winter. The west coast is crowded with 'snow birds.' Gas has been a problem. Most stations are on a quota, and we have a little difficulty getting it. I was invited to a M.I.T. meeting in Naples, which is 70 miles from here. If I had another M.I.T. alumnus around, I would have liked to have gone. I keep busy, with golf, house chores and gardening. This winter I have harvested some cauliflour, broccoli, snow peas and lettuce."

Clayton F. Jarvis of Amesbury, Mass., like many of us, worked in various non-professional fields during the great depression. Finally, in the middle thirties, he got in the construction field, worked for a number of contractors such as E.R. Badger, Stone and Webster, Spofford and Thorndike and finally the General Services Administration until his retirement. His work with the GSA took him all over the country and overseas. He had a heart seizure in 1974 and open heart surgery, which limited his vigorous activities. He spends his winters in Sarasota, Fla., and is enjoying life in retirement.

Chung-Foy Yee of Canton, China, one of the distinguished members of our Class, visited M.I.T. this spring for the first time since graduation. While at M.I.T. meeting Paul Gray, Jerry Weisner and others, a dinner reception was arranged at the Faculty Club by **Bill Baumrucker** and **Jim Fahey**. **John Rich**, **Jerry Gardner**, our general chairman for the 55th Reunion, and your secretary met Chung-Foy for a very enjoyable meeting.

Doris and Bill Baumrucker visited Chung-Foy while in China in April. Bill observed: "Chung-Foy is a great person with an outgoing personality. At present, he is a professor of metallurgy at the South China Institute of Technology in Canton. Until now, except for a brief visit to Germany in 1936, he has not been out of China since he received his master's degree at M.I.T. in 1931. During the Cultural Revolution under the Gang of Four he was banished to distant mountains, along with other educated professional men, to do hard labor. He was starved to the point of weighing only 100 pounds and didn't expect to come out alive. Finally, when things became normal, he was reunited with his family and went back to his post at his beloved Institute. His hospitality toward us in Canton was great; we visited his home and met several members of his family, including his charming wife, who had been a pharmacist before the 'troubles,' and son Lang-Sang, who graduated from the Institute in 1966 just as the Gang of Four came into power. At that time he burnt all his books, papers and stamp collections so that the Red Brigade couldn't find any evidence of intellectuality and then fled to a distant island where he worked for ten years. Now back to his post as a 'technician' developing life-sustaining equipment in use in open-heart surgery, Lang-Sang has a pretty wife and a 3-year-old daughter who called us Great Aunt Doris and Great Uncle Bill. Chung-Foy's daughter, who also lives with him, is a physicist and her husband a chemist. Seeing them all was a great experience for us. Right after we left China, Chung-Foy came to Detroit to deliver a paper at an International Metallurgical Conference. Afterwards, he came to Boston where Doris and I had him to dinner at our Marblehead home with Dorothy and Professor **Herman Meissner**.

From Boston, he went to New York and met another classmate, **Warren Walker**. Chung-Foy is a charming person and a very loyal and enthusiastic member of M.I.T.'s Class of 1929." — **Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

30

Intermittent showers and a chilling mist failed to dampen the spirits of the members of the Class of 1930 at Chatham Bars Inn for our 50th reunion. Though last-minute cancellations had reduced the attendance, some 82 classmates (including three coeds), 65 wives, one fiancee, 10 children and 4 grandchildren participated in one or more of the scheduled activities. At the class meeting opening the Chatham Bars portion of the reunion **Ralph Peters**, president, **Ed Kingsley**, treasurer, and your secretary reported briefly. According to the treasurer, the 45th reunion generated a deficit of about $1,800, but accumulated interest over the last 5 years left a balance of $1,840 to cover the expected deficit on the 50th reunion. On the basis of data collected over the last five years, your secretary reported that the quinquennial shrinkage of the class roll was about 12 percent; surviving classmates comprise 88 percent of those living as of June, 1975; we have an average of 1.9 children, with the range being from zero to seven; and we have between zero and fifteen grandchildren, with the average being 2.7. **Greg Smith** as class agent reported that the class gift target of $500,000 had been exceeded shortly before the reunion. Pledge cards were distributed to give classmates who wished an opportunity to make a last-minute pledge. The gratifying results of this final appeal are reported below.

On Monday several groups headed optimistically for golf courses, but heavy showers in the afternoon curtailed play; so the greater part of the day for most of us was devoted to exchanging information about retirement activities, children and grandchildren. At the class banquet on Monday evening Professor Philip Morrison spoke to the general thesis that the miracle of the human brain is its ability to operate at the frontiers of both science and the arts. To illustrate this, Professor Morrison pointed out a number of instances in which patterns generated by computers in connection with scientific or engineering problems have analogic counterparts in the arts.

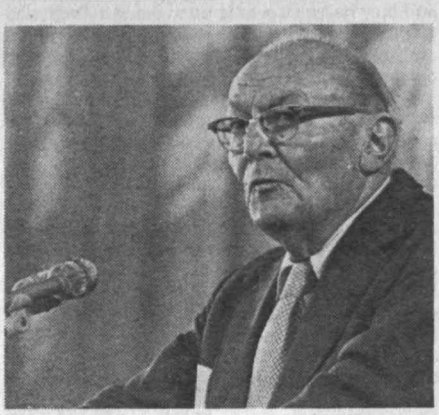
On Tuesday the weather was still marginal for athletic activities and, indeed, for the traditional reunion clambake. The event was scheduled for outdoors, and optimistically the tables were set up and initially occupied by classmates with rain gear close at hand. But part way through the steamed clams the weather worsened, and upon arrival of the lobster, all but one sturdy foursome of us ran for cover. The afternoon was pieced out with bridge games and informal conversations.

On Wednesday we moved to Cambridge where most of us were quartered by M.I.T. in Burton House. At a brief class meeting at dinner that evening **George Wadsworth** was elected class president and Ed Kingsley and yours truly were re-elected treasurer and secretary, respectively. The principal speaker at this dinner was our distinguished classmate **Ching Yang** of Shanghai, China, who attended the reunion with his wife, Sally. Ching is a consulting electrical engineer to the Shanghai Bureau of Textile Industries (2,000,000 spindles) and adjunct professor of management at Chiao Tong University, Shanghai. Sally's father and uncle once owned an enterprise that operated nine cotton mills and eight flour mills in the Shanghai area. While such holdings were expropriated at the time of the "liberation", it appears that the present regime is making some restitution to "former capitalists" who became "socialist workers". Ching very briefly traced the history of the Peoples Republic of China and then described the current efforts to modernize. In this connection he mentioned the burgeoning cooperation between the U.S. and P.R.C., and we learned that Professor Yang and his wife gave a reception at which Chairman Howard Johnson and President Jerry Wiesner were guests of honor during a visit of members of the M.I.T. Corporation last March.

With no daytime events planned on Thursday, June 5, many of us decided to go sightseeing in downtown Boston. We discovered, as most of you know, that the downtown area has been very largely rebuilt since our years at M.I.T., and much of the refurbishing has occurrred in the last five years; we found the Quincy Market area especially interesting. By 4:30, however, all were ready for the reception and delicious buffet supper at the President's House, where the particular focal point of interest was the large and valuable painting by a disinguished Chinese artist donated to M.I.T. by Professor and Mrs. Yang.

After supper we were bussed to Symphony Hall. No doubt it is a sign of advancing age, but your secretary found the Boston Pops program conducted by John Williams less to his liking than the Fiedler programs of earlier years. This and the remaining events of Technology Day are described elsewhere in this issue. But one item of special interest to the Class of 1930 deserves space here: The final report, made jointly by Ralph Peters and **Dick Wilson** as co-chairmen of the fund-raising committee, on the 50-year gift. The final figure announced was a very respectable $781,000, about $200,000 more than the amount collected prior to the reunion. The difference is accounted for by the fact that classmates at the reunion pledged an additional $50,000, and we were credited with $150,000 as the value of the painting donated by the Yangs. Ralph and Dick also announced that M.I.T. will eventually receive another $900,000 in testamentary bequests from members of our class.

Even before the late afternoon reception at Walker Memorial, Louise and I, like most of our classmates, decided that six active days were enough and headed for home. In general those attending favored another reunion in 1985, and plans for the 55th will be reported in due course. — **Gordon Lister**, Secretary, 530 Fifth Ave., New York, NY 10036



$781,311 to M.I.T. from the Class of 1930 — the report delivered by Ralph W. Peters (above), president of the class, at the Technology Day luncheon on June 6.

As a senior, Robert H. Riehl, '30, was chairman of the senior ring committee; a year before he'd helped choose a new design for the M.I.T. class ring — the now-familiar "brass rat" — so before he graduated Mr. Riehl received the first ring ever made in the new design. Back for his 50th Reunion, Mr. Riehl gave his "brass rat No. 1" to M.I.T., and it was put on display at Historical Collections as he and his classmates enjoyed a reunion reception amidst the memorabilia there. President Paul E. Gray, '54 (right) chuckled as Mr. Riehl recalled the $19.50 price in 1930; today's ring in 14-karat gold sells for more than $300. (Photo: Gordon R. Haff, '79)

31 50th Reunion

Following is the copy of a letter just received from **Dave Buchanan**, our 50th Reunion chairman. You will undoubtedly have received much of this information by direct mail. "There are not many details available yet on next year's 50th Reunion, but the committee is being formed and is already at work. For starters, the following have met from time to time, Evelyn and **Howie Richardson**, Polly and **Ken Germeshausen**, Jean and **Claude Machen**, Charlotte and **Ed Hubbard**, **Hal Gurney**, **Dick Baltzer**, Dorothy and **Dave Buchanan**. Others will be asked to help, and all committee member's wives are invited to participate. So far no one has turned down an opportunity to work on this great event. The committee is very happy that the response to Claude Machen's appeal last year for $25 or more to rebuild the class treasury was so successful as it gives us some working capital. There are 454 living members of our class with known addresses according to Alumni Records. It is our hope that 175 to 200, including spouses, will return for this once-in-a-lifetime event. Someone suggested recently that this will be "our last fling," which was corrected quickly to "our last big fling," for we are already looking forward to our 55th.

We hope to gather off-campus on Sunday afternoon, May 31, 1981, probably on Martha's Vineyard, with an exciting program there. Many have never visited this island retreat and it should provide new experiences as well as golf, fishing, boating, swimming (provided it is warmer than this year, though Ed Hubbard will go in no matter how close to freezing it is), and maybe a clambake. We will return to Cambridge on Wednesday, June 3, with inexpensive housing on campus and some hotel rooms available nearby for those who wish a little more luxury. A dinner in some exotic place in Boston is being planned for that evening. Thursday morning will be at leisure with an opportunity to do some sightseeing in Boston and environs, and that afternoon there will be a reception and buffet dinner for our class at the president's house prior to Tech Night at the Pops. Friday, June 5th, is Technology Day with a chance to see something interesting on campus during the morning preceding the annual Alumni Luncheon, at which time our great 50th year gift will be presented. The Class Gift committee is headed by Ken Germeshausen. All members have received work on our goal to raise $1,375,000, abbetted by that grand $500,000 challenge gift. All gifts and pledges over a five-year period count toward this objective. This is going to be the greatest 50th Reunion on record, so don't miss it."

A note from **Fred Elser**, dated Sunday June 8, says "Just received the May issue of *Tech Review* the other day. It comes over here about a month later than you fellows get it on the mainland. (Fred

lives in Honolulu). *Worldradio* also just arrived and they had a nice write up of me in it. I've typed the first draft of my Ph.D. dissertation outline and am taking it in for approval/criticism day after tomorrow. It's a slow process and my "tremor" makes me quite slow on writing and typing. — the only two ways I can compose satisfactorily. I'm aiming for getting my degree by next December.

Henry Hartwell writes "Constance and I are looking forward to our 50th Reunion next year." . . . **Leslie Reed** says "Retired from building construction but continue to manage apartments." It is a pleasure to report that no death notices have been received since the last notes. — **Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; **Ben W. Steverman**, Assistant Secretary, 3 Pawtucket Rd., Plymouth, MA 02360; **John R. Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158

32

I attended Technology Day on June 6, 1980 and was pleased to see some of our classmates there. **Harry Johnson** suggests that on the 50th Reunion the class meet somewhere on the Cape.

Al Dietz suggested that for its 50th year gift, our class endow a professorship. He would like to see it in building technology.

John Brown had just come from viewing the tall ships with the M.I.T. Club of Boston. He also was invited to have dinner aboard the *J. F. Kennedy* carrier by the Lieutenant Commander. He found it all very colorful. . . . Other attendees at Technology Day were: **Wendall Bearce**, **Melvin Castleman**, **Douglas Miller**, **Thomas Weston**, **Carroll Wilson**, and **Charles Taylor**.

There was a memorial service at the M.I.T. chapel for all M.I.T. alumni reported deceased from June 1, 1979 to May 20, 1980. The following were from the class: **Harry M. Arnold**, **Lawrence W. Bailey**, **Herbert H. Brown**, **Edward E. Burritt, Jr.**, **Steven A. Coons**, **George R. Daniels**, **Daniel P. Dyer, Jr.**, **Frederick W. Green**, **William H. Hadley**, **John C. Lyon**, and **Robert D. McGilvra**.

We received the sad news that **Dirwood M. Danforth**, 69, died of a heart attack on April 11, 1980, at his home in Palm Coast, Fla. Born in Saugus, Mass., he graduated with a degree in mechanical engineering. Before moving to Palm Coast two years ago, he was an executive in the research and development division of the Singer Co. in Elizabeth, N. J., retiring in 1975. A resident of Bridgewater, N. J., for more than 20 years, he served on the Bridgewater Board of Adjustment. Also, he served for a time in the Somerville, N. J., Chamber of Commerce. During World War II, Dirwood was in the Pacific and held the rank of colonel in th U. S. Army Reserves. His survivors include his wife, Dorothy, a son, Douglas Danforth, and a daughter, Susan Danforth.

Edith Arnold sends us the sad news that her husband, **Harry M. Arnold**, passed away on February 9, 1980. We learn also that **C. Castle Day** died in January. Our class sympathy to the bereaved families. — **Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

33

Banner headlines this time around are for **Bill Pleasants**, who sent John Mattill a photo-copy of his article which appeared in the May issue of *Civil Engineering*. The article is critical of our immense super highway system which in far too many cases, creates traffic jams near cities, thereby wasting gas and time. The answer seems to be to build flyovers — structures that allow traffic to cross over the intersecting road.

We have two letters from Christine and **Emmy Norris** of Newcastle, N.H. Emmy had a massive stroke five years ago and now seems to have made a satisfactory recovery.

A short report on Technology Day, June 6: I did not arrive too early but did reach John Mattill's sherry party for class secretaries. I miss secretaries who were good friends and who have passed on; George Warren Smith, 1926, Gene Smolley, 1919, and Earl Wilson, 1912. But I did see Gordon Lister, 1930. I also went to the 1933 table in the Cage, where I sat with Roz and **Ellis Littman**, Anne and our heir apparent **Fred Murphy**, **Ben Liberfarb**, **Julian Klein** (my old Course II pal) and Rita and **Tom Galvin**. Although he did not sit with us, I spoke briefly with **Chuck Fulkerson**.

To those who have never been to an Alumni Day, it is the day when reunion classes announce their gifts to M.I.T., and it appears that M.I.T. will not suffer too much.

Ellis Littman did get to China earlier, though I got no details. . . . The **Fred Murphys** made a big change this winter; they spent part of their time on the Florida Gold Coast, Palm Beach and North. I got a card from Bermuda, where he has spent winters in the past when not making with the skis. . . . We have two letters from **Cal Mohr**. Cal sent me a brief story on Three Mile Island, which I enjoyed. I asked him to whom I might send it, and (in the meantime) I sent it to my son. Cal later offered the name of an old friend, **Wayne Taul** of Fresno, Calif. I asked my son to return it, but he won't think of it. Cal seems to be a bit disturbed about TMI, claiming it is not far enough away (about 15 miles).

It seems that **Bob Smith** and his good wife now restrict their antique business to the greater Rochester, N.Y., area. Bob has eight grandchildren; six near home, and two in Oregon. . . . One of my greatest pleasures is to get a note from **Beau Whitton**, who encloses a letter copy from **Cooper Cotton**. . . . It seems that Beau, in cleaning out the attic of his house, found an old scrapbook with articles from the *Boston Globe*, 1930-31. The articles were on M.I.T. and two fellows who were doing research at a local brick plant. The fellows involved were from Beau's Course, XVII. Fred Murphy might be the man to whom to send the scrapbook. I do hope the book finds its way to the right spot. Anyway, Murphy will get the mementos. . . . Cooper Cotton works part time in the Department of Facilities Management, University of Missouri.

Now to get to a story closer to home — about **Wm (Bill) Kilbourn**, Course II. I have not seen or heard of Bill since we graduated. However, a long article in the Waltham, Mass. *News Tribune* tells us the whole story. Briefly, Bill is a clock fixer. Bill entered M.I.T. with the class of 1933, and after earning his degree in mechanical engineering, he went directly to Waltham, where he took a job as an office boy at $10 per week. Bill eventually became Division Superintendent of the clock company. Later, he worked for the New Haven railroad and then with the Mitre Co. He retired from Mitre in 1972, and founded his own clock company with his friend, John Proctor. In the basement of Bill's house, he and John produce 350 to 400 Banjo clock movements per year. He says that the Banjo clock is the only clock 100 percent American in design.

This time, we have found but two of us who have departed this life: Lt. Col **Carl U. Burbank**, of San Clemente, Calif., passed away on April 25, 1980. We have no details. The other classmate who has left us is **Eugene Sullivan** of Woburn, Mass. Gene passed away suddenly May 18th. Gene was in Course XVII of our class, and was active for many years with Thomas O'Connor, a construction company in Cambridge. For the last 15 years, he was executive vice president of the Slotnick Co. of Boston, Mass. Gene and a fellow 1933 man, **Tom Galvin**, were very close, having married two sisters. Gene is survived by his wife, Marian, two sons and five daughters. I knew Gene quite well, and it sort of shakes me up to hear that he is gone. Our entire class sends its sincere sympathy. We sure have lost one of our good ones — **Warren J. Henderson**, Secretary, Fort Rock Farm, Drawer H, Exeter, NH 03833

34

In looking back at the May issue, where I mentioned my plans for going to England, I am reminded of Burns' immortal words about "the best laid plans of men and mice. . . ". We got off all right on April 30 and had two enjoyable weeks in the Cotswolds, London and its art galleries, and a visit to friends on the south coast. Then on May 14 I got a telephone call from New York that my 83-year-old aunt was terminally ill. Since my side of the family was only she, me, and my sister, there wasn't much choice but to cut the trip short and come home. I had to miss out on the big railroad celebration, but the fact that we got back in time for her to see us (she hadn't wanted us to be told!) was ample recompense. The cathedrals, great houses, etc. will be there for another year.

Julius Goldberg writes, "After 45 years as a retailer of men's hats, (Harry the Hatter in New Bedford, Mass.) the well known hatter in S.E. New England retired in August, 1979. Looking forward to a trip to England to bike ride in the Lake country and the lowlands of Scotland." The lowlands of Scotland may be all right for biking, but Julius had best be careful — that's where most of the distilleries are located.

Peter Kalustian is still managing to make business work for his pleasure. He says, "My health is good. Just finished a very active skiing season in New Jersey, Western Canada, and Vermont. My consulting business continues to be active. I plan several business trips to Malaysia and other Asian countries. Perhaps I may find time for touring in the Mediterranean countries. (he should plan to come home that way.) I keep close to my two children and their families, including my two young grandchildren living next door."

I am sorry to report the death of **Wilcox Overbeck** in Aiken, S.C. on May 8. He had a career that was devoted almost exclusively to the field of nuclear work. In 1942 he had joined Enrico Fermi's group at the Univeristy of Chicago in the metallurgical laboratory and was a member of the original team that achieved the first nuclear chain reaction. He then moved to Oak Ridge and the Clinton Laboratories. The following year Mr. Overbeck became superintendent of the instrument department of DuPont at the Hanford Engineering Works. He stayed there as works engineer when G.E. took over after the war and then became manager of their Syracuse Tube Works. He returned to the atomic field when he took part in the design, construction, and operation of the A.E.C.'s production plant in Aiken. He retired after 30 years with Du Pont and then began lecturing on astronomy at the University of South Carolina. This was an outgrowth of many years of the study of astronomy and the construction of several telescopes, incorporating features of his own design. Mr. Overbeck is survived by his widow, Daphne, a son, two sisters, and three grandchildren. As you can see, he had contributed greatly to a new field of science and technology and our condolences go to his entire family.

You may recall that some months back, in writing about **George M. Cunha** and his preeminence in the field of document preservation, I wondered how he got from chemistry to a navy captain to his present field. Well, an article on his work, from Birmingham, Ala., of all places, gives some answers. He had been working as a chemist when he joined the Navy prior to World War II as a pilot and weapons specialist. What began as a three-year enlistment culminated in his retirement as a captain in 1963. All this time he had pursued an interest in collecting and preserving books about wooden ships and sailing vessels and this brought him to his second career at the Boston Athenaeum, where he was conservator for many years.

I had a note from **George Bull** who had to miss our reunion but who this year managed to combine Technology Day with a 50th reunion at Andover. He found that, besides himself, only **Irving Kusinitz** and **Henry Morse** were signed up. He enjoyed the buffet supper with a couple from the class of '50 and Pops with his nephew who was in the class of '46. (Who says ecumenism is dead?) At the luncheon next day he was with **Simon Malkin** and then off to Andover.

I can now start marking days off until next spring when I expect we can resume our interrupted trip. At least I have on hand a good beginning for an itinerary. — **Robert M. Franklin**, Secretary, 620 Satucket Rd., (P.O. Box 1147) Brewster, MA

02631; **George Bull**, Assistant Secretary, 4601 N. Park Ave., Apt 711, Chevy Chase, MD 20015

35

Fifty-six '35ers came back for the 45th with about 40 wives and friends and most of us agreed that it was the best reunion yet. The poor weather at the Cape only served to provide more time for catching up with the news. M.I.T. put us up at the new Hyatt Regency on Wednesday and Thursday night, and those beautiful facilities put us in the right mood for the reunion. Wianno Club and its staff made us feel welcome and at home. Most of us thought it a great idea to come back at our 50th. Everyone who ventured anywhere on Saturday morning was caught in a late morning downpour and came back to dry out and have lunch.

The golfers managed five holes except for **Goffe Benson** who made it all the way around, and won the low gross prize. At our first dinner together on Friday night, **Tom Hafer**, who came from Brussels with his wife, won the prize for coming the greatest distance — 4,100 miles. The food served was superior. Friday evening was informal with clusters of people talking and watching movies and slides shown by **Ed Taubman**. Saturday afternoon was strong on bridge and more groups indoors. That evening after the clam bake, **Bernie Nelson** took over and doled out the following prizes: Having the most grandchildren (nine!) — **Bob Flood**; Looked most like his 1935 picture — **Jim Eng**; Attended the most reunions — **Ed Taubman**. **John Taplin** presented prizes to the tennis players: **Sylvia** and **Walt Stockmayer**. **Hank King** presented the golf prizes to Betty and **Leo Beckwith** and Rose and **Ellis Flink**. Door prizes were won by Helen Libby, Rhoda Nelson, **George Forsburg**, **Don Wood**, and **Hank King**. **Leo Beckwith** won the prize for being the best in three standard ballet positions, a contest run by Sylvia Stockmayer. Sunday morning after breakfast we held our Class business meeting with president **Bernie Nelson** presiding. **Pete Grant** reported for the nominating committee of which **Bob Forster** was chairman and Leo Beckwith the third member. The following nominations were made: president, **Bernard H. Nelson**; vice president and treasurer, **Randy Antonsen**; assistant treasurer, **Phoenix N. Dangel**; secretary, **Allan Q. Mowatt**; 50th Reunion gift chairman, **John R. Taplin**; vice chairman and class agent, **Leo M. Beckwith**; vice chairman and estate secretary, **Hal L. Bemis**; area vice presidents: New England — **Edward J. Collins**, Westchester and Fairfield Counties — **J. Goffe Benson**, Long Island — **E. Donald Gittens**, Phila-Trenton-Wilmington — **Philip P. Johnston**, Baltimore-Washington — **Edward H. Taubman**, Florida — **John H. Colby**, Texas-New Mexico — **W. Earl Peterson**, Mid-West — **William W. Cross**, Northwest — **John B. Ballard**. It was unanimously approved that the nominations be closed.

Bernie Nelson read a letter from **John Taplin** accepting his election as 50th Reunion gift chairman and reporting that his committee had set a goal of $1.5 million for the drive to start July 1, 1980. Leo Beckwith suggested that those planning major gifts consider making five installments, one each year. Hal Bemis will be working on bequests. Randy Antonsen, treasurer, reported the class treasury should be in reasonably good shape after it pays all bills related to the reunion.

A suggestion was made that on our 48th year we individually plan to attend the Mexico M.I.T. Fiesta in Mexico City in March, 1983. A majority of those present would like to see our 50th Reunion be a joint one with three days at M.I.T. and three days at the Wianno Club. It was also requested that the Committee arrange to have M.I.T.'s Chairman of the Corporation speak and answer questions at our next reunion. When Bernie asked for help in putting together a 50th Reunion booklet, **Lars Ekwurzel** volunteered to take on the job. **Allan Mowatt** reported anticipating receiving more letters from classmates as they retired, but is hasn't worked out that way. So, he asked that the wives write and send the kind of information they like to read in the Class notes. He promised that he would acknowledge every letter received. (I have cleared this with Doreen incase you have perfumed paper!). Another suggestion: if you write a Christmas letter to your friends, consider sending a copy to the class secretary. For those interested in contacting other classmates or alumni, you can obtain an up-to-date address by telephoning the Alumni Association office (617) 253-8270.

Please start Operation Letter now. My next deadline is Sept. 9 for publishing in November. — **Allan Q. Mowatt**, Secretary, 61 Beaumont, Ave., Newtonville, MA 02160

36

45th Reunion

The major item of news this time is that plans for our 45th reunion are firm and commitments have been made. The schedule has had to be revised because of the availability (or unavailability) of suitable facilities. We are back in the standard groove, starting at M.I.T. on Thursday with cocktails and dinner preceding Pops on Thursday, June 4, and moving to the Cape after luncheon on Friday. The site selected is the Wychmere Club at Harwichport. According to **Fletch Thornton**, reunion chairman, it was selected "primarily for its beach front, pool area, view from the rooms, and interesting nearby surrounding harbor and village." The formal program will end with luncheon on Sunday. So mark your calendars, make your plane reservations, if required, and plan to attend our 45th! . . .

At luncheon on Alumni Day I sat with Kitty and **Herb Borden**, Rose and **Ed Dashefsky**, Vivienne and **Eli Grossman**, and **John Zietlow**. Rosalie and **Jack Chapper** had been at the Pops with the Dashefskys, and **Herb Metten** and **Ben Cooperstein**. Ed Dashefsky, according to Rose, has been busier than ever since his retirement from Raytheon. Consulting, Ed is finding, is rewarding, but the pressure is off.

A letter from **Dick Denton** included a check for the reunion kitty and news of the activities of Denton Vacuum. When I visited with Dick and Virginia in Marlton, N.J., a year or so ago, Dick described a new product, Denglas, a nonreflecting glass for framing pictures. The glass reduces reflection over 90 percent without blurring or distortion. I was interested because I have framed enlargements of my photographs. Dick reports that they are now getting the bugs out. He and Virginia hope to "gradually retire," and have been looking for a new and larger boat. If they are successful in their search, we can expect them to arrive at our reunion by boat!

Your secretary took some kidding at the Alumni Day luncheon about her "final" mini-reunion this October 25. Since I cannot entertain you all without an assist from my daughter Martha, this was a joint decision. This fall will be your last chance! Saturday, rain, snow, or shine, for luncheon and/or supper, you will be welcome in West Hartland, every one of you.

Now, for a personal note, I took time off from my many volunteer activities to drive West in May and spent two weeks in Utah camping with Martha, and exploring Zion, Capitol Reef, and Bryce National Parks. We had hoped to visit the North Rim of the Grand Canyon but it was still closed when our time was up. En route, I touched base with my other three children in Indiana, Illinois, and Ohio. It was a fun trip but I am glad to be home and will be waiting to hear from you. — **Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, CT 06091

38

The second annual class dinner was held June 6 at the Wayside Inn in Sudbury. Present were **Norman Bedford**, **Paul Black**, **Armand Bruneau**, **Roscoe Cooper**, **Paul Des Jardins**, **Frank Gardner**, **Haskell Gordon**, **G. Edwin Hadley**, **Horace Homer**, **Roy Hopgood**, **Robert Johnson**, **Solomon Kaufman**, **Frank Kemp**, **Norman Leventhal**, **David Morse**, **Paul O'Connell**, **Don Severance**, **David Wadleigh**, and respective spouses. Plans (and reservations) have already been started for the third annual dinner, to be held on Technology Day, June 1981.

Bob Johnson has relinquished his post as chief executive officer of Arkwright-Boston Manufacturers Mutual Insurance Co., but is avoiding retirement by continuing as chairman of the board. . . .

Richard Muther, '38

Dick Muther, president of Richard Muther and Associates, was awarded the 1980 SME Engineering Citation. Present at the awards banquet as a one-man 1938 cheering squad was **Horace Homer**. . . . **Sam Steere**, in Tacoma under the shadow of Mt. St. Helens, had part of his past resurrected in the April issue of *Air Classics*. It is an excellent write-up on Sam's experiences in the 397th Group in 1944 and gives a vivid picture of the European bombing missions at that time. Incidentally, Sam had nothing to do with the writing of the article.

Gordon Foote is now retired, and has taken up residence in the shadow of the Smokies at Columbus, N.C. Another retiree is **George Skaperdas**, who retired after 39 years with Pullman-Kellogg.

Our west coast assistant secretary, **Harold Strauss**, reported that **C. C. Wong** called him on one of his trips from Hong-Kong. It is Harold's guess that C.C. will probably become a permanent U.S. resident within a year. He ran into **Al Minott**, who is one of the senior engineers with the L.A. Department of Water and Power. . . . **Gene Hochman** is with the South Coast Air Quality Management District. I think this means no smog for L.A. Harold also reported that **Joe Pasternack**, also with Hughes, passed away this spring — **A. L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, MA 02633

39

Burk Kleinhofer and **Leonard Mautner** attended a luncheon in Los Angeles during May where they heard Howard Johnson, Jerry Weisner, and Paul Gray summarize the splendid achievements of the $250 million Leadership Campaign.

Aletta and **Bob Touzalin** often visit neighbor **Wiley Corl** in southern Florida. Recently **Bob Schmucker** paid them both a visit.

Bob Casselman had a heart attack on a Florida tennis court and now is recovering on Cape Cod at 133 Scraggy Neck Rd., Cataumet, MA 02534, (617) 563-6337. Dodie says Bob would love to hear from our classmates, so why not pick up a pencil or a phone and have the fun of visiting Bob right now!

We are saddened by the death of classmate **James A. Smith** of East Dennis, Mass., on January 23, 1980. No details were given. — **Hal Seykota**, Secretary, 1421 Calle Altura, La Jolla, Calif. 92037

40

The reunion, celebrating our 40th year after graduation, was a super long weekend in Cambridge and West Dennis, despite those drenching rains on the Cape.

A total of 178 — 94 classmates together with wives, sons, and daughters (see box) — enjoyed the opportunity to renew old friendships. This was an excellent turnout for a class which had suffered severe losses during World War II.

It is appropriate to recognize those who worked

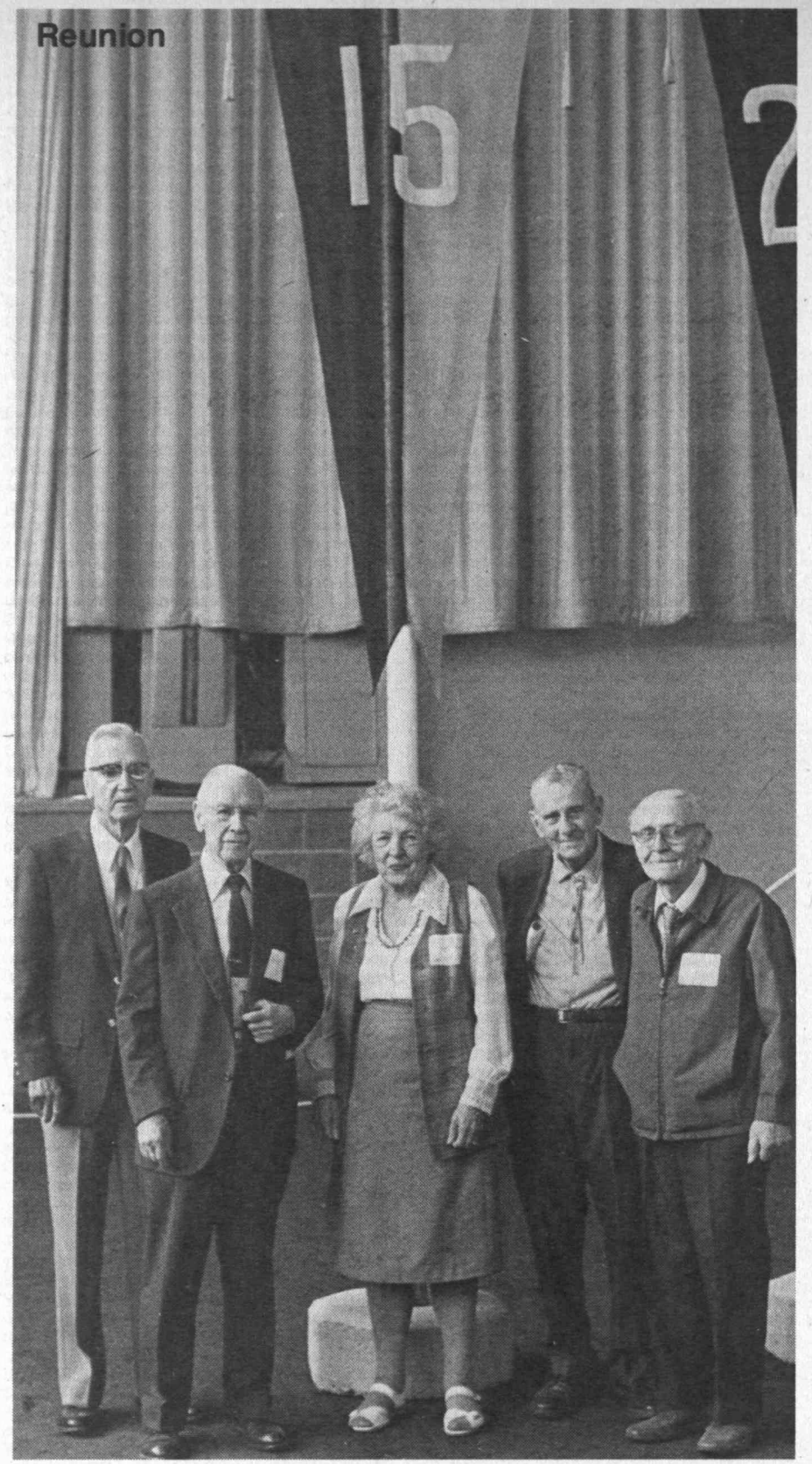
so hard for so many months to make the reunion a success. Although 18 were named on the committee letterhead, many more contributed in a number of ways. President **Bruce Duffett**, and chairman **Jack Danforth** set up the over-all program, which included an excellent 40th Reunion Book. Particular credit should go to **Jim Baird**, **Sally Bittenbender**, **Maureen Feldman**, and Anne Wells, Alumni Association Reunion Coordinator, for their tireless efforts in compiling all of the information sent in by you classmates and other records from the Institute to make this book a treasure which we will all preserve. If you are interested in knowing what your classmates have been doing with their lives during the past 40 years, you will surely want a copy: just send your dues check to **Ed Bernard**, our treasurer. He deserves particular acclaim for his work in handling all of the financial details, including dunning us for class dues, reunion and registration forms, etc., as well as handling the registration details at McGregor as we arrived. And what a view of Boston's skyline across the Charles from those rooms!

At the Technology Day luncheon in Rockwell Cage, our vice-president, **Norm Klivans**, presented our report to M.I.T.: $550,000 donated by the '40ers during the last five years. This amount was given by 307 graduates, 63 percent of our classmates, with no individual gift in excess of $25,000.

The Boston Harbor cruise on a sunny, warm, Thursday morning was most interesting, with approximately 100 people viewing the new Boston skyline, several tall ships lingering in the harbor, Old Ironsides, etc. After the cruise we used the opportunity to explore the restored Faneuil Hall market area and visit the numerous shops and restaurants. Those of use who went on to the Lighthouse Inn at West Dennis were delighted with the charm of Cape Cod. However, as usual for the Class of '40, it rained, and rained, and rained! Tough on the tennis players, but it kept us together as a group and made for a great party.

At our Class meeting the following new officers were elected to serve for the coming five year period. President, **Russ Haden**; vice-president, **Jim Baird**; treasurer, **Ed Barnard**; and secretary **Don Erb**. In addition, **Jack Danforth** was acclaimed poet laureate. If you have never heard any of Jack's verses be sure to sign up for the 45th. We know that he will be ready with a few lines about each of you.

By unanimous vote, **Sally Bittenbender** and **Maureen Feldman** were made honorary class members in recognition of their efforts and contributions to the class. The "Fuzzy Beaver" Awards followed, and then came the Saturday night music which provided an opportuity to demonstrate that the class of '40 is far removed from that old rocking chair. This reunion illustrates that our class has trmendous adhesiveness and vitality. But we need to hear from those who were unable to attend so that when the 45th arrives we will set an all-time record for those participating. And as class secretary, all that I can write about is what *you* send to me. *Please swamp me* with mail. — **Don Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030



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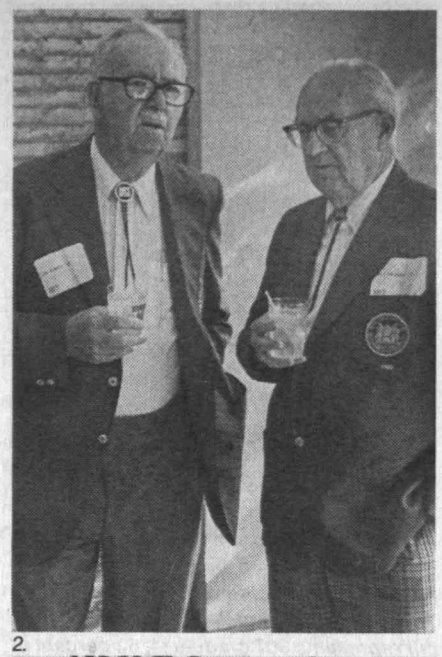
42

Jim Littwitz, "Mr. M.I.T. of Rochester," recently did a talk on photographic paper at the prestigious International Conference of the Society of Photographic Scientists and Engineers. Jim has been busily putting Kodak photographic paper into those big yellow boxes ever since he graduated and returned from military service in 1946.

Bill Pease has been named a consulting engineer at Raytheon Co. in Lexington, Mass. This position is the highest professional scientific and engineering level which is attainable at Raytheon. It is given in special recognition of continually outstanding research and engineering achievements over a long time. During his career at Raytheon Bill has held many engineering and management positions including that of manager of Space Systems and manager of the company's Apollo program.



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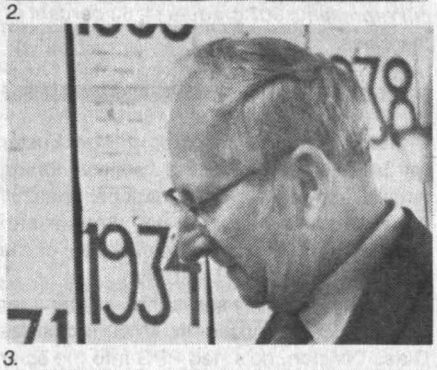

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1. Representing Class of 1915 on Technology Day, June 6, were (left to right) John Homan, Wally Pike, Mary Plummer Rice, Evers Burtner and Horatio Lamson. (Photo: Gordon R. Haff, '79) 2. Jim Howard (left) and Milt Salzman, Class of 1925. (Photo: Gordon R. Haff, '79) 3. Walter Smith, '28, checks the reunion attendance list. 4. Class of 1935 at Historical Collections. 5. The oldest and the newest. Technology Review's *reception for class secretaries on June 6 brought together Kenneth A. Turkewitz, '80 (left), and John J. Nolan, '03, whose contributions during the coming year will be last and first, respectively, in this section of Class News. Seventy-seven years after graduating from M.I.T., Mr. Nolan was the oldest alumnus at the Technology Day luncheon. 6. Class of 1955 met at Rivers School for a clambake. 7. Wally Pike, '15. (Photo: Gordon R. Haff, '79) 8. Class of 1955 celebrate their 25th Reunion.*

8.

Members of the Class of 1940 and guests attending the 1980 reunion:

Martin and Davette Abkowitz
Ed and Betty Adams
Dick and Jo Babish
Maury and Hazel Baer
Jim and Jan Baird
Arnold and Gerturde Benton
Ed and Jeanne Bernard
Sally Bittenbender
Ken and Bebs Bodger
Paul and Carlene Bollerman
Benjamin Bosher
George and Feances Bradshaw
Scott Brodie
The Harvey Browns
Roy and Frances Brown
Greg and Maggie Bry
John and Irma Burr
Tito and Gladys Cabrer
John Casey
Robert and Priscilla Church
Arnold and Naomi Copeland
Ed and Winnie Crosby
Jack and Judy Danforth
Charles and Beatrice De Mailly
Bob and Marcia Deutsch
Millard Dowell
Bruce and Petra Duffett
Doug and Lois Eckhardt
Charlie and D.J. Edwards
Don and Sue Erb
Maureen Feldman
Jim and Jeannette Fifield
Maurice and Joyce Flynn
Dudley and Marge Follansbee
Ollie Fulton
Morris and Eleanor Gabel and family
W.H. Krome and Jean George
Sam and Diana Goldblith
David and Jeanette Goodman
Bob and Marian Gould
John Gray
Bill and Anne Green with Fran and Frieda Schmale
Joseph and Edith Greenberg
Al Guttag
Russ and Nancy Haden
Bill and Grace Hagenbuch
Fred and Pat Hammesfahr
Harold and Helen Hawes
Ralph Hayward
Fredyum and Katherine Henrickson
Joe and Olivia Jefferds
Larry and Roslyn Jones
John and Patricia Joseph
George and Katherine Kaneb
John Kapinos
Ted and Edith Kingsbury
John and Elizabeth Kirk
Norm and Alice Klivans
Frank and Sophia Libman
Dick and Laura MacPhaul
Ty and Cynthia Marcy
Rafael and Julia Martinez
Marshall and Bobbie McCuen
John and Edith McKee
Bob and Brownie McKinley
Bob and Anna Millar
Ralph and Gunlog Millet
James and Beverly Moore
Dave and Lindsay Morgenthaler
Bob and Harriette Nedell
Joseph and Jana Owens
Leo and Angie Pach
Wes and Marion Pendleton
Sam and Joy Rabinowitz
Steve and Elizabeth Rhode
Alfonso Raizo Patron and Lola Remy
Dick and Mary Ellen Spalding
Bill Stern
Phil and Lucille Stoddard
Barrett and Marge Taft
Theodore and Mary Talbot
Dick and Jane Talpey
William and Mary Taylor
John and Joan Vanderpoel
Edward Wallace
Arnie and Betty Wight
Nicholas and Louise Williamson
Paul and Norma Witherell
George and Phyllis Wolfe
Loren Wood
Boger and Elsie Wright
Gary and Marion Wright
Alfred Wu
Jay Zeamer

$550,000 to M.I.T. from the Class of 1940 — the report delivered by Norm Klivans (above), vice-president of the class, at the Technology Day luncheon on June 6. The gift represents 307 graduates, 63 percent of the class.

The Class of 1940: After 40 Years a Running Start

Its reunion book proclaims that "life (for the Class of 1940) begins with 40." But if that's the case, it begins from a running start. "What your classmates have achieved . . . it is astounding," wrote Bruce Duffett, president of the Class, in his pre-reunion greetings. Here are some examples of what he meant, taken from notes submitted by Mr. Duffett's classmates for a 40-year book:

— **Alfred N. Ackerson** and his wife Marijean have been "foster parents to over 30 children in the past 13 years and have adopted three special ones. Our youngest is autistic and nonverbal, and our 11-year-old is hyperactive and has learning disabilities." (In his "spare time," Al works for Chrysler in Syracuse, N.Y.)

— **Edgar W. Adams, Jr.**, is a sailor; during the last decade he's made a trans-Atlantic crossing and sailed the Annapolis-Newport and Marblehead-Halifax races. He's director of patents at Bell labs.

— During the first years of his professional career **Richard C. Babish** was technical adviser to two Cinerama movies (remember?): "This is Cinerama" and "Cinerama Holiday" and technical director for the Cinemiracle production 'Windjammer." But the best was yet to come; during the last five years he's made his first optical element — a 60-inch telescope primary which is "the best of its class for the moment."

— Tiring of chemical engineering and textile fibers, **Scott Brodis** bought the Depot Restaurant in Pensacola, Fla., in 1970; now he's "retired" from the food business to be a member of the sales staff at the Pensacola Hardware Co.

— **Clement F. Burnap**, working for Kaiser Engineers, Oakland, Calif., has traveled to 105 countries since leaving M.I.T. — the last of them being the Peoples Republic of China, Romania, and all of Central America.

— **Clifford H. Cracauer** brought five different companies from money-losers to high profitability, then decided to share his skills with others as a management consultant.

— **Charles F. Demailly** says his accomplishments in the 40 years are "hard to specify, if any." But in that period he's been successively president of Plymouth Cordage Industries, executive vice president of Emhart Corp., and (now) president and chief executive officer of PCI Group, Inc., and the Dominion Tack and Nail Co. (Canada).

— While he was president of Schreiber Cheese Co. (for nine years — he's now retired), **Robert Deutsch** increased the company's sales seven-fold to $350 million a year and similarly increased its net worth.

— **David R. Goodman** is president of a "string of five small chemical companies;" from a start in his garage in 1947, they've gone to $10-million-a-year sales. But now, says Dave, his activities are "declining on all fronts."

— After helping turn five companies from loss to profit, **Russ Haden** decided nine years ago that he wanted a company of his own. So he's now president of Taylor Industries (everything to install floor coverings) c Conyers, Ga., "making slim margins and growing."

— **Joe Havens** has left his professional psychologist job and now lives on 19 acres of woodland adjacent to Quabbin Reservoir, Shutesbury, Mass., a mile from the road. "We envision this 'sylvan' life as one aspect of a revolution which will turn our world around so far as values and life-aims are concerned."

— **John L. Joseph**, inventor of Blockbuster toy blocks, calls himself a "political liberal activist," a member of the national board of Americans for Democratic Action and founder of the North Jersey chapter of the American Civil Liberties Union.

— **Robert McKinley** saays that, as manager of technical services in PPG Industries Glass Division, he's "led PPG into the solar era."

— After 25 years in industry (engineering, research and development, R & D management, and general management), **James H. Moore** made "a complete career change by going into academia (North Shore Community College, Beverly, Mass.) and getting involved in environmental activities."

— **Karl Pfister** has "retired to the country (Londonderry, Vt.), where I strive for self-sufficiency along with wife, cat, three horses, and a dozen beef animals, plus a couple of pigs in summer."

— Retired from an Air Force career, **John A. Vanderpoel** is making "special wheelchairs for handicapped athletes and restoring antique bicycles and tricycles for museums and collectors."

— **Edward M. Wallace** says that for the last five years he's "battled inflation, battled Internal Revenue, and battled aging. . . . Just love to battle!"

— After 28 years at Lincoln Laboratory, **Herbert G. Weiss** retired, made an "'8,000-mile sailboat cruise with my wife to Guadeloupe and return," and now is "trying to do something about the energy problem through wind power."

— Surface mail takes "several months" to reach **Eugene S. West**; use air mail, he says. He and Ms. West are retired on a small farm in Punta Gorda, Belize, Central America.

In a good letter, **Steve Stephanou**, chairman of the University of California's Applied Systems Department, tells us that he recently wrote a book entitled *Management: Technology, Innovation and Engineering*. Steve's publisher is Daniel Spencer of Malibu, Calif.

Marty Levene just attended his 30th Boston University Medical School Reunion and received the Distinguished Alumnus Award for his contributions in the field of radiology. Our congratulations to Marty.

Another first for the Class of 1942! Geophysical Service Inc., a division of Texas Instruments, has named its new Ice-Class ship *M/V Edward O. Vetter* in honor of **Ed Vetter**, a former president of Geophysical Service and a retired executive vice-president of Texas Instruments.

Fellow class secretaries: Do any of you have ships named afer classmates?

In a departure from our usual custom of obituaries for classmates only, we note that **Adrian Marcuse**'s wife Jan died recently after a three-year bout with cancer. Jan was well-known to many of you and I'm sure that you all join me in offering sincere sympathy to Adrian and their three daughters. Jan was deputy mayor of Glen Cove, Long Island, and worked at her job at City Hall up to a few days before her death. She was on the Glen Cove Planning Board, a member of the Land Use Commission and directed the Glen Cove Library Information and Referral Center.

By the time you read these notes it will be late August, but nonetheless very best wishes for a happy and healthy summer. — **Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, N.Y. 10605

44

Following the Technology Day reception at Walker on June 6, **Burt Bromfield**, **Andrew Corry**, Jane and **Lou Demarkles**, **R. J. Horn**, **Norm Sebell**, **Melissa Teixeira** and **Howie Weaver** met at the M.I.T. Faculty Club for dinner. Hope *you* can join the group next Technology Day.

The Memorial Service for M.I.T. alumni at the M.I.T. Chapel on Technology Day honored our classmates, **Edward H. Hong**, **Mortimer W. Meyer, Jr.**, **Richard B. Plame**, and **Newton A. Teixeira**.

I was so pleased and thankful to hear through Flap Facts that **John Woolston** and his wife Laura, who had been helping to put the Imperial Iranian Naval Shipyard in Bandar Abyss into operation, were safely evacuated with the help of the Iranian, British, and U.S. navies. John writes that he is now working with Bechtel on an Algerian industrial development project while Laura is with DOE.

My apologies to **Arturo Morales** who sent me a suggested plan for a trip to Mexico and the Yucatan peninsula together with costs. I failed to pack his letter with my things for a California trip just before class notes were due. Your reunion committee expects to meet this summer and will decide whether to select this trip for us or whether to join the trip sponsored by the M.I.T. Club of Mexico, usually the third week in March. More later.

Ronnie and **Art Peterson** stopped to see me recently while returning to their home near Lake Placid. They had spent the weekend attending Art's 40th Reunion at Andover. They remarked that they had been doing much traveling to help establish chapters of Compassionate Friends and had been as far west as California and Las Vegas.

Keep me informed of your activities or you may be forced to read all about mine. — **Melissa Teixeira**, Secretary, 92 Webster Park, West Newton, MA 02165

45

As an Alumni Association staff member so aptly stated, your classmates and their spouses look exceptionally well some 35 years after graduation. Yes, we have aged well; very few of us appear to be in our mid-fifties — but we are! Yes, our 35th Reunion was a roaring success despite our usually '45 Cape Cod weather — it rained again (or still!).

The Reunion "package", which ran from Thursday, June 5 to Sunday, June 8, was as follows: Registration Thursday afternoon followed by cocktails and dinner at — of all places — the old Grad House now known as Ashdown House. Although Fran and I did not stay overnight, we understand that the accommodations are superior to those many of us enjoyed from July 1, 1943, through June, 1945! Tech Night at the Pops was followed by wine, cheese, and whatnot into the wee hours of the morning.

Following the Technology Day luncheon, your reunioning classmates drifted off to Cape Cod and the wonderful Wynchmere Harbor Club in Harwichport — and what a gorgeous day; sun and warm Cape water with soft ocean breezes; five hearties made the ocean. Friday evening found our happy throng seated as a group which allowed the conversation to flow freely — and the orchestra, God bless them, played tunes from the 1940's which was helpful to all.

Saturday was a typical '45 day at the Cape — a beautiful sunrise followed by clouds that turned into a downpour at about the time the two golfing foursomes reached the eighth hole at Chatham Bars. Saturday's activities now became bridge, trips to town, antiquing, and long afternoon naps. Our 1800 Class Meeting was followed by cocktails, a clam bar, and an excellent clambake. A few hale and hearties, after a quick cleanup, again tripped the light fantastic while others talked or played cards.

Sunday was an "in and out" day in that we had sun, clouds, rain, plus a two-hour electric outage — yet **Nick Mumford**, Fran Springer and Mary Hoaglund enjoyed an ocean swim while many took lengthy walks on the beach or breakwater. A few left before lunch whereas the bulk departed soon after another wonderful Wynchmere meal. Our hats are off to **Gerry Quinnan**, Reunion Chairman, for organizing an unorganized reunion. Several of the girls, however, are threatening to overorganize our 40th. Before check out, arrangements were made to return to Wynchmere and Harwichport in 1985. Who knows, we might have three days of sun.

The following slate of officers was elected: **Gerald V. Quinnan**, president; **Clinton H. Springer**, secretary; **James B. Pickel**, treasurer; class agent and 40th reunion gift chairman, **Christopher G. Boland III**; regional vice presidents: **Frank J. Gallagher** — New England, **Albert E. Bowen, Jr.**, — New York, **John J. Freiberger** — Southwest, **George E. McKewen, Jr.** — Chicago, **James B. Hoaglund** — Chicago, North, and **Sheridan C. Ing** — West.

One might question the need for such a large number of geographical VP's for the Institute's smallest class — however, it is expected that Chris Boland will use these individuals as henchmen in his effort to develop a meaningful 40th reunion gift.

Reunion attendees were: Eva and **Peter Agoston**, Jean and **Chris Bolland**, Billie and **Al Bowen**, Ellen and **Jim Brayton**, Dorothy and **Marshall Byer**, **Enrique J. DeMajo**, June and **Frank Donohue**, Kate and **Jack Freiberger**, Dee and **Frank Gallagher**, **Guy Gilleland**, Nancy and **Charlie Hart**, Mary and **Jim Hoaglund**, Julia and **Sherry Ing**, **Don Kuehl**, Ann and **Bob Maglathlin**, Anne and **Andy Marocchi**, Jeanne and **Bill Martin**, Louise and **Tom McNamara**, Janice and **George McKewen**, **Art Miller**, **Nick Mumford**, Jan and **Charlie Patterson**, Mary and **Gerry Quinnan**, Fran and **Clint Springer**, **Ed Stolz**, Carol and **Bob Welch** — and via phone Jerry and **Buzz Busby**, Betsy and **Tom Hewson** plus a 4 a.m. call to Al Bowen from **Sam Duff** in Pittsburgh.

See you next month — **Clinton H. Springer**, Secretary, Box 288, New Castle, NH 03854

46

35th Reunion

I am very pleased to report that we received fine letters from **Margaret Garritsen De Vries**, Ph.D. '46, and **Peter G. Drayton**, '50. I hope that this will inspire more alumni to write us.

Margaret Garritsen DeVries was one of three women to graduate with Ph.D.'s in economics in 1946. Recently, Mrs. DeVries, **Ruth Gilbert Shaeffer** and **Louise Fryer Curley** had a little personal reunion in New York City, the first time the three women had been together since graduation. They were the only women in the graduating class, and they compared their careers as women economists: all have been successful.

Geophysical Service, Inc., a division of Texas Instruments, has named its new ship M/V Edward O. Vetter, *in honor of Ed Vetter, '42, a former president of Geophysical Service and a retired executive vice-president of Texas Instruments.*

Louise Curley has been with the investment firm of Scudder, Stevens and Clark in New York City since her M.I.T. days. Ruth Shaeffer has held different high posts and most recently has been at the National Conference Board in New York City. Margaret DeVries has been with the International Monetary Fund in Washington, D.C., since her graduation. The ladies agree on how hard it has been as women economists in their times and that many of the younger women have an easier time of it.

All three are wives and mothers (Ruth's daughter is an alumna of M.I.T.) as well as economists. They compared notes on the articles they had authored and published and found that they were all contributing to the Ellen Swallow Richards Chair. Mrs. DeVries said it was a grand evening and they agreed to meet again, only this time they will not wait 34 years.

In April, 1980, Mrs. DeVries not only received a Distinguished Alumna Award from the University of Michigan (where she received her A.B. in economics) but also celebrated her 28th wedding anniversary with her husband, Barend A. DeVries, Ph.D. '51.

Peter G. Drayton was part of the class of 1946 until his education was interrupted at the end of his sophmore year. Dr. Drayton is a visiting professor of psychiatry at the University of Pittsburgh, where he is doing clinical pharmacology research.

Frederick J. Ross, Jr., president and chief operating officer of Raybestos-Manhattan, Inc., Trumbull, Conn., was elected to the additional post of chief executive officer on March 1, 1980. . . **Herbert J. Hansell**, a partner in a Cleveland law firm, has been elected a director of Gray Drug Stores, Inc., a large northern Ohio drug and discount store operation headquartered in Cleveland.

Our 35th reunion is on the horizon for next June, and the chairman, **Jim Goldstein**, reports arrangements for a great weekend. On-Campus activites include Tech Night at the Pops for Thursday, June 7, 1981, and Technology Day on Friday, June 8. On Friday afternoon, the reunion will move to Woodstock Inn in Vermont for Friday evening, Saturday, and Sunday. That venerable

navy salt and renowned after-dinner speaker Curt Canfield has accepted our invitation to speak at one of our dinners in Woodstock. Further information on the reunion will be forthcoming shortly. Until next time — **Russell K. Dostal**, Secretary, 18837 Palm Circle, Fairview Park, OH 44126

47

Several sources this month, including Technology Day visits home by some, a few reached by telephone during the telethon, and another marvelous dinner with **John Karmazin** (and wife Sandra, too, this time). (Should I mention that Claude You-Know-Who couldn't make it again? He hates it when I talk about the things he doesn't get to.) And the clipping services and news releases tell us about the things that prople won't mention themselves:

Walter Rotman, '47

Walter Rotman was recently honored by the Armed Forces Communications and Electronics Association (AFCEA) for inventing a device now used in electronic systems that intercepts enemy radar signals. Walter was cited for ". . . developing the Rotman lens . . . an outstanding example of technology transfer from the laboratory to full scale production equipment . . . and for having played a key role for over 30 years in the areas of antenna and microwave technology development. . ." The device is now part of the U.S. Navy countermeasures systems that picks up enemy radar signals and jams them to obscure a ship's location. Walter has been with the Air Force and Hanscom since 1948. He lives in Brighton with his wife Molly, son Stanley, M.I.T. '79, staying on for graduate work, and daughter Ruth, a freshman in electrical engineering at M.I.T. . . . **Marty Haas** has retired from the Electronics Systems Division, U.S. Air Force, and is concentrating on golf, music, and fixing up the house.

Parker Symmer, with five in college, is not retiring this year. Fred is at Hampshire, Bob at Bates, Whit at Colby, Bill is pre-med at St. Lawrence, and Ginger is at Macalaster. . . . hypothesis two, inc., is a management consulting firm built on the premise that small is beautiful (and more effective). . . . **Hrand Saxenian** is proving his point in a number of companies, in addition to his research and writing. Wife Lucy is teaching English at Concord High School; Jennifer is at the Rhode Island School of Design; Anna Lee finishing her M.S. at Berkeley; Steve, at Colby, is interested in physics and tennis coaching: watch him, he may make a noise in racquet design; and Mike finished this year at Stanford, having spent his junior year based in Italy biking around Europe. He is now in Indonesia in a two-year job cultivating local technology in an effort to help the Indonesians develop economic self-suffiency.

Claude Brenner handed over the gavel to **Harl Aldrich** with appropriate ceremony and remarks at the Technology Day Luncheon. We expect that others will step forward to continue the Class of '47 Dynasty thus begun. Harl, for his part, is celebrating his election to the presidency of the Almuni Association with a trip to Singapore to visit the long-neglected alumni there. He also hopes to transact some business, but without Lois, who would prefer a cool-weather trip. . . . From **Carl F. Jenkins**: "Spent the period September, 1978, to July, 1979, on a Department of Commerce Science and Technology fellowship working in Washington, D.C., with the House Committee on Science and Technology as a staff member on the Energy Subcommittee and the Natural Resource and Environment Subcommittee."

George Welti is project staff director at COMSAT Labs. . . . **John Ebersberger**, of Albertson, N.Y., has retired from Western Union and is now with the Power Division of the N.Y. Public Service Commission and continues to be active in Boy Scouts. . . . On the West Coast, **Ginny Ferguson Ean** has been president of the local council of Campfire Girls for the last couple of years. She travels around the country a lot and enjoys it.

Rear Admiral **Wayne E. Meyer** (USN), AEGIS Shipbuilding Project Manager, Naval Sea Systems Command, spoke at the Dedication of the AEGIS Production Test Center at RCA Missile and Surface Radar. AEGIS is the U.S. Navy's new radar-based, computer-controlled system capable of detecting, tracking, and engaging multiple missile, aircraft, and surface threats simultaneously. Wayne cited the uniqueness of the AEGIS team program performance as something that has never been done in the Navy before.

Jean N. Tariot, vice-president and general manager of Honeywell Information Systems, Inc., a unit of Honeywell, Inc., has resigned to pursue private interests. . . . From Falls Church, Vir.: **Joe Talago** is in the financial end of things with the American Gas Association, a trade association in Arlington, Vir., which provides information to the Wall Street crowd. . . . **Max Arnold**'s youngest was graduated from high school this year. Max is still with General Electric, in the Lamp Division at Nela Park in Cleveland. . . . **Albert Hylas** is in Military Radar with Sperry Gyroscope Co. in Great Neck; lives in Port Washington. Had an upcoming business trip to Rome when I spoke with him.

You can't grow avocados from seed to reproduce fruit, says **Alfred Parziale**, who has an avocado orchard. Alfred is with Delco Electronics, Santa Barbara, in military avionics systems, which means guidance and navigation and military computers for aircraft and missiles and business trips around the country. His three sons are all engineers, married, and living on the West Coast. . . . **Bob Devine** is in the process of getting his own Wall Street operation started, Robert Devine Associates. . . . Among the two dozen M.I.T. Alumni in top collegiate posts are **James Ham**, president of the University of Toronto and **George Russel**, chancellor of the University of Missouri, according to *Tech Talk*.

No *Long-Lost* list this month; we'll catch up next time. See what happens when you keep in touch! May it be an inspiration to those of you with broken pencils (Sharpen up.). Love to all, **Ginny Grammer**, Secretary, 62 Sullivan St., Charlestown, MA 02129

48

Verity Smith described the Fiesta that the M.I.T. Club of Mexico City sponsored last March. Verity and Anita, Margaret and **Cliff Moss** and **Robert Klausmeier**, his wife and two guests represented '48 at the Fiesta. After cocktails and dinner in Mexico City, Paul Gray, M.I.T.'s new president, spoke to the gathering. The next day buses took everyone to Morelia. Before leaving Mexico City, Verity and Anita were dinner guests with Paul and Priscilla Gray at the home of Doris and Bob Wilcox, '58, scientific advisor to the U.S. Embassy.

Donald J. Atwood, Detroit Diesel Allison general manager and General Motors vice president, has been elected to the National Academy of Engineering. Don was cited for his contributions to the theory and engineering of inertial navigation for aircraft and missiles and microprocessor controls for internal combustion and turbine engines. A native of Haverhill, Mass., he was on the staff of the Instrumentation Lab and was associated with the research work that pioneered the development of inertial guidance systems. He joined GM in 1959 as an associate director of the Boston R and D Lab of the AC Electronics Division. In 1961, he became director of the facility. The following year, he was transferred to AC's Milwaukee operation as director of sales and engineering. He became director of Milwaukee Operations in 1968. After promotions in 1970 and 1973 he was elected a GM vice president and in 1978 became general manager of Detroit Diesel Allison Division.

Donald Atwood, '48

Henry Morgan, professor of management policy and director of the Master of Business Administration Program at Boston University, has been appointed dean ad interim of the School of Management. . . . **Milton A. Widelitz** has his own consulting firm. Also into aviation-related real estate with Aerolease Associates in Los Angeles. . . . **Elliot Bates** is keeping his architect/engineer office going and watching four grandchildren grow up, usually from a safe distance. Elliott's office is in Auburn, Maine. . . . **Robert Gurney** is finishing installation of the interaction vacuum chambers for Stanford University's PEP (positron-electrion) Ring. The last of his five children finished college in December, 1979, and he is looking forward to semi-retirement in the near future. . . . **Ken Brock** was a speaker at a business forum luncheon at the Chemist Club in N.Y.C. Ken's topic was, "They never told me fund-raising was fun." . . . **Bob Devine** has been with Piper Aircraft in Vero Beach, Fla., since July, 1979. He is a senior structures engineer.

F. W. Furland has been an officer of the M.I.T. Club of Southern California for the past two years and is on the Board of Governors. He has been living in the foothills of the E. San Fernando Valley and working for the L. A. County Communications Department. He is presently project manager for a county-coordinated paramedic communication system and for the fire command and control system. — **Marty Billet**, Secretary, 16 Greenwood Ave., Barrington, RI 02806

49

Now is the time
For all good men
To come to the aid
Of their Class.
Send news of youse
Or newers of yours.

Gerry Walworth was inducted into the Hall of Fame for High School Hockey Coaches of Massachusetts. . . . **Roger Moore** is still in Brussels working for AFIA Worldwide Insurance. . . . **Lucas Mayer** must be retired. He's not only chairman of the Conservation Committee, but also on the Sewer Study Commission of the Town of Seekonk, Mass. . . . **Andy Bigus**, who reads different magazines than your secretary, reports that *Forbes* magazine, May, 1980, ran an article about **Milt Bevington**'s efforts to conserve energy through his Atlanta based Servidyne Co.

Are you a member of the calculator culture? Can you join your secretary as 1.0 times a husband, 5.0 times a father, 2.9 times a grandfather, and a 4.5 tennis player? If so , please send comparable statistics and let me know who sponsored the Joe Penner shoe. — **Paul E. Weamer**, Secretary, 5130 Regent St., Madison, WI 53705

50

Lawrence G. Sirkis reports that he is a self-employed structural engineer with an office in Stoughton, Mass. His most recent project is a full service center for Fitchburg Gas and Electric Light Co. Also, Lawrence and his wife, Anne, are new grandparents. They welcomed the arrival of

Heather Jill Lieberman on April 9, 1980.

Robert C. Tweit, and his wife, Joan, are enjoying retirement immensely. Bob tells us it is more of a career change for them as they find many fascinating volunteer jobs available in the out-of-doors for organizations such as the Nature Conservancy, U.S. Park Service and U.S. Forest Service. . . **William Black, Jr.** has been elected president of the Indiana and Michigan Electric Co. . . . **Ross S. Karlson** has been promoted to chief engineer of diesel products at the American Bosch Engineering and Research Center. He has served as engineering director of diesel products, with responsibilities for diesel fuel injection research and engineering programs at the center. He joined American Bosch in 1950 as a lab technician.

Simplex Wire and Cable Co. of Portsmouth, N.H., announces the recent appointment of **Kenneth P. Roberts** to the position of program manager. He will assume responsibility for the development of a high-voltage riser cable system for the ocean thermal energy conversion program. Under the direction of the Department of Energy, the project is to determine the feasibility of harnessing solar energy by utilization of the temperature difference between deep ocean waters and warmer surface waters to produce electricity. During his 21 years with Simplex, Ken has held various positions in engineering and marketing. He lives in Exeter with his wife, Norma, and is the father of two daughters.

Robert L. Plouffe, Jr., has been named president of Computer Sciences Corp.'s System Division located in Falls Church, Va. Since joining the corporation in 1970, he has held a series of senior management posts in the systems group. Bob has a distinguished background in digital communications technology spanning 30 years, and patents have been granted in seven countries on his pulse communication systems inventions. He resides in McLean, Va.

Francis F. Lee has authored an article, "Teaching Entrepreneurship," which was presented in May, 1978, at M.I.T. and published in the April, 1980 issue of *Chemtech* magazine. Francis is professor of electrical engineering and computer science at M.I.T. He received his undergraduate and graduate education at M.I.T. and, during a work study program, contributed the idea which led to the development of the first automatic Chinese typesetting machine: the Sinotype. He returned to M.I.T. after serving eight years in various engineering and management capacities at Remington Rand UNIVAC. At M.I.T. his research centers around sensory aids for the handicapped and digital systems applications. He is responsible for the commercial development of Varispeech, an electronic speech time-compressor/expander machine. He founded and is now chairman of the board of Lexicon, Inc., a company dedicated to digital sound equipment for the recording industry.

Kenneth H. Olsen, founder and president of Digital Equipment Corp., was awarded the Franklin Institute's 1980 Vermilye Medal for outstanding achievement in industrial management on May 12. Ken founded Digital Equipment Corp. in 1957 with just $75,000 in seed money. Today, the company is the largest minicomputer maker in the world, currently accounting fo around 40 per cent of the $5 billion-plus world-wide minicomputer market. — **John T. McKenna, Jr.**, Secretary, 1 Emerson Place, Boston, MA 02114

51 30th Reunion

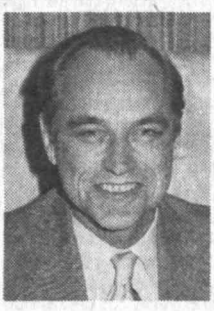
Jim Ballou won the first Charles Bulfinch Award by the Doric Dames at the Statehouse in Boston, Mass. The award cited Jim's restoration work in the Salem renewal area and *U.S.S. Constitution* Museum. Jim continues as an architect in Salem, and has also started a new venture, Derby Management, Inc., a real estate planning and construction business in Massachusetts and the West Indies. . . . Bose Corp. of Framingham, Mass., founded in 1964 by Dr. **Amar Bose**, Professor of Acoustics at M.I.T, has reported that this will be a second year with sales in excess of $50 million. Bose employs nearly 800 workers at its Framingham plant and has manufacturing facilities in Canada, Ireland, and Puerto Rico.

Richard Fidler, '51

Richard Fidler was named vice president of engineering for Sylvania Systems Group, part of Gerneral Telephone and Electronics Corp. in Waltham, Mass. Dick continues to serve as vice president-general manager of the Group's Communication Systems Division, headquartered in Needham. Dick, who resides in Stowe, is also a vice president of the New England chapter of the National Security Industrial Association, chairman of the COMCAC executive committee of NSIA, a member of the Institute of Electrical and Electronics Engineers, Sigma Xi, Sigma Pi, Sigma and Phi Beta Kappa.

Richard Hammer has been serving on the M.I.T. Educational Council in Sheridan, Wyo., since 1973. We wish to thank Dick for a superb job done. Dick's son Ed is serving on the M.I.T. Educational Council in Boston.

Walter Kinzinger has moved up to associate department head of W-37, Command and Control Communications, for the Mitre Corporation. Walter has been with Mitre for 19 years and was most recently supervisor of the DCS Architecture Group.



William Krivsky, '51

William Krivsky has been elected president and chief operating officer of Compo Industries, Inc., of Waltham, Mass. Bill moved to Compo Industries from his position as senior vice president of Certain Teed Corp. in Philadelphia. He will continue to serve as a director of Krauss-Maffei Corp., a large machinery and chemical manufacturer in West Germany.

W. J. Milne has joined the engineering faculty of Memorial University of Newfoundland, which has started a full course in shipbuilding engineering, the first complete program of its type in all of Canada. He completed his career as a consulting naval architect with the firm of German and Milne in Montreal.

Bernard Rothzeid has been awarded a grant from the National Endowment for the Arts for a study of the chattel houses of Barbados. Bernard is president of Rothzeid, Kaiserman and Thomson, P.C., an architectural firm in New York City which has recently won the National Honor Award of the American Institute of Architects, the Albert S. Bard Award of the City Club of New York, and two New York State Architectural Association Awards. Bernard, who is a long-term resident of Park Slope, Brooklyn, has been elected to the College of Fellows of the American Institite of Architects, is a full professor of architecture at City College, and sits on the board of Cooper Union and Methodist Hospitals in New York City.

As director of resource planning, Nelson C. Lees, '51, was a "key factor" in the $225 million Leadership Campaign, and part of its success was undoubtedly due to his tireless efforts behind the scenes. It all came "up front" on Technology Day when President Wiesner handed Mr. Lees (left) the Gordon Y. Billard ('24) Award. (Photo: Gordon R. Haff, '79)

Alan Roberts, '51

Alan Roberts has been elected vice president for strategic systems at the Mitre Corporation's Command Control and Communications Division in Bedford, Mass. Alan, who lives in Carlisle, has been associated with the technical activities of Mitre for 21 years.

William Spicer has received the 1980 Buckley Award of the American Physics Society. Bill won a Guggenheim Fellowship in 1978-79 and is a Fellow of Churchill College, Cambridge, England. . . . One of your classmates, **Paul Grady**, is trying to keep his golf game in shape, and to prove it, shot another hole-in-one during a tournament of the Connecticut Chemical Club held at Burning Tree Country Club in Greenwich. The ace was scored on the 133-yard second hole at Burning Tree with a soft nine-iron shot that covered the pin all the way, landed about 6 feet beyond the cup, drew back and out of sight to the amazement of his fellow competitors. Your secretary also won low gross with a 76 in competition with 110 golfers at the Connecticut Chemical Tournament. Keep those cards and letters coming while you are enjoying your summer vacation. — **Paul H. Grady**, Secretary, 16 Brook Ln., Westport, CT 06880

54

We have just celebrated Bunker Hill Day here in Charlestown (June 17, 1980) and have been advised it is time to get our notes together for the August/September issue of *Technology Review*.

We recently received a short note from **John Griffiths** informing us that he is currently technical director of the General Defense Intelligence Programs, which involve the army, navy, air force, and Defense Intelligence Agency. John is a graduate of Course IX.

Congratulations from the chancellor. Paul E. Gray, '54 (left) greets Tabetha Frey, '80, at the Commencement reception on June 2 while her proud father, Walter P. Frey, '56, looks on.

Dr. **David W. Dennen** has been named managing director of Lilly Research Centre in England by Eli Lilly and Co. He had been director of antibiotic technical services in Indianapolis since 1975. David received his B.S. in quantitative biology from M.I.T., and the Indiana University School of Medicine awarded him a master's in biochemistry in 1964 and his Ph.D. in microbiology in 1966.

Dr. Dennen joined Lilly in 1954 as an associate physical chemist. After serving in the army from 1956 to 1959, he remained in the National Guard, attaining the rank of colonel. (He was named commandant of the Indiana Military Academy of the Indiana National Guard in 1979). He returned to the company in 1959, and in 1966 he was named a senior microbiologist. In 1969 he became manager of antibiotic development and two years later was named director of the area. In 1974 David was transferred to Eli Lilly International Corp., a Lilly subsidary, as managing director of Lilly Pharamachemie GmbH (West Germany).

Dr. Dennen is a member of the American Chemical Society, American Society for Microbiology, the Dean's Industrial Advisory Committee at Indiana University/Purdue University, Indianapolis, and is listed in the *American Men of Science* and *Who's Who in America*.

Congratulations, Dave.

Genevieve Lavedan Ubel informs us that her son, Andrew, is a junior at M.I.T., and her younger son, Peter, has been accepted into next year's freshman class.

We are happy to report that **William Browder**, currently a professor of mathematics at Princeton University, has been elected to the National Academy of Sciences. Election to the Academy is considered one of the highest honors accorded an American scientist or engineer.

Congratulations to Bill for a most prodigious honor.

We are sorry to inform you that **Edward A. Kaszynski** passed away on March 29, 1980. Ed was a graduate of Course II and resided in North Reading, Mass. On behalf of our class, we offer our condolences to his family.

In closing, we hope you are all having a relaxing and safe summer. Keep in mind that there are only four years to go to our next reunion. — Co-secretaries: **William Combs**, 120 West Newton, Boston, MA 02118; **John Kiley**, 7 Kensington Rd., Woburn, MA 01801; **Louis E. Mahoney**, 14 Danby Rd., Stoneham, MA 02180; **Dominick Sama**, Chestnut Hill Rd., Groton, MA 01450

55

It was a glorious gathering. Our 25th Reunion was an outstanding success. There was an attendance of 115 enthusiastic class members, who with their companions swelled the ranks at the Class Banquet to 200. Thursday evening began with a buffet at McCormick Hall, followed by Tech Night at the Pops, and dessert and coffee after viewing the much-improved Huntington Hall. The 25th Reunion gift of our class is pledged toward the cost of this renovation; and through the generosity and committment of class members there are, at last count, 75 sponsored chairs and a gift total of about $250,000. This show of support can be bettered if you are willing to add your name to the list by contacting the Alumni Association, **Ed Ehrlich**, or **Pete Toohy**.

After Technology Day, the Class banquet was held at the Great Hall in Quincy Market. For those who had not been to Boston recently, wandering by the stalls of Quincy Market was a fascinating experience; and the evening of dining and dancing was delightful. One of the class co-secretaries attempted to mar the evening by reciting statistics gathered from the class questionnaire, but the attendees were having such an enjoyable time that they simply continued their conversations.

On Saturday a clambake was held in Weston, where the often intense sun of June was avoided. Throat dryness was kept to a minimum through exposure to atmospheric moisture and malt beverage. That evening there was a reception at the M.I.T. President's house, where Dr. Wiesner graciously hosted us before we left for the Boston waterfront. The museum of Transportation is now located in an ex-warehouse with a delightful ambiance and arrangement of all sorts of vehicles. We occupied the entire top floor, and there was a buffet that filled anyone who had any room left for food. A band entertained those who were still ambulatory, and there were exhibits and films to go with the conviviality.

On Sunday morning a lavish brunch at McCormick Hall gave everyone an opportunity to discuss the events of the weekend and to make promises about meeting again at the next reunion. It was an exceptionally enjoyable and satisfying gathering, both for the food, entertainment, and events, and for the sociability and camaraderie of the participants.

The 218 returns of the reunion questionnaire have been compiled, and future columns will include items from this profile. If you want a copy for yourself, send the proverbial self-addressed envelope to one of the co-secretaries.

If you are willing to spend a little time on class activities, we want to hear from you. The time has come for a change of pen, and we actively solicit your participation in reporting and writing class news. If you are interested, please don't let the potentially Pulitzer-winning moment pass; write to us. — Co-secretaries: **Marc S. Gross**, 341 South Bedford Dr., Beverly Hills, CA 90212; **Allan C. Schell**, 19 Wedgemere Ave., Winchester, MA 01890

56 25th Reunion

Our once and only 25th reunion is rapidly shaping into a memorable event for June 4 through 7, 1981. The main events are traditionally centered around campus during Alumni Weekend, but your committee is planning some exciting supplements to the Institute's official hospitality. **Bill Grinker**, our president emeritus and reunion chairman, is organizing volunteers, suggestions, and contributions. He'd appreciate hearing from you at American Computer Group, Inc., 712 Beacon St., Boston, 02115; 617-261-1100. Bill is now president of this firm, which he co-founded with Sonny Monosson ('48). He's also president of the Computer Dealer's Association with 101 members active in the $2-billion computer resale business.

Ed Baker and **Howard Bertan** have suggested a few days of reunion activities in Bermuda before we gather in Cambridge. The committee will consider this — but in the meantime Ed would like to hear from those interested in such a trip. His law office is at 299 Park Avenue, N.Y.C., 10007; 212-486-1550

Roger Borovoy is leading the challenge, with class agent **Walter Frey**, to inspire contributions for our 25th reunion gift. We're planning to establish a class of '56 Career Development Professorship at M.I.T. — with a fund of $250,000. This amounts to only about $12 per classmate for each of these 25 years since 1956. Obviously, most of us have benefited by more than a hundred times that rate from our affiliation with M.I.T. The generosity of older M.I.T. alumni has helped to make and maintain the prestige that contributes so much to our pride and prosperity. Now it's our turn to reach deeper. Roger's committee will soon be contacting each of us. Please, let's respond with a worthwhile return on the investment. Roger, by the way, is still general counsel of Intel Corp. — the leading manufacturer of integrated circuits. He recently also took responsibility for their computer-aided design and corporate security areas.

Ed Zoolalian was reelected to the Monrovia, Calif. City Council. He's still with Neff Instrument Corp. there. . . . **James Allen III** of Stone & Webster Engineering in Boston was recently appointed chairman of the ASME-ACI Joint Committee for Concrete Reactor Vessels and Containment. . . . **Andre Kermabon** started his own firm, Syminex, in 1974, based in Marseilles, France, with subsidaries in the U.K. and Norway. The firm specializes in offshore instrumentation, uranium assaying logging systems, and enhanced petroleum recovery. He's looking for potential U.S. associates, especially in the Gulf Coast area, with the possibility of exchanging representation of U.S. interests in Europe in return.

Jerome Vielehr was named president of Joseph Schlitz Brewing Co. in Milwaukee. He was vice-president of International Trade at Coca Cola, and earlier had been president of Aqua Chem, Inc. in Milwaukee. . . . **Henry Imus** is a civilian engineer with the U.S. Marine Corps at Camp Pendleton, Calif. He had been with Hughes Aircraft until about seven years ago. — Co-Secretaries: **Bruce Bredehoft**, 7100 Lanham La., Edina, MI 55435; **Warren Briggs**, 33 Baucroft Rd., Wellesley Hills, MA 02181, 617-235-7436

End Game

by Peter Felsenthal, '54

Nukes,
no nonsense,
they say we gotta
negotiate,
we have eight horsemen,
they have eight horsemen,
we insist seven is all that's necessary,
but we conceive five more,
they conceive five more,
no one understands our position
better than the horsemen
who know
four is enough.

57

Edward Roberts, professor of management at the Sloan School, has recently provided substantial material for thought. "What Do We Really Know About Managing R & D" appeared in the March issue of *Chemtech*. An article in the *Boston Globe* (April 30) entitled, "The Professors Have Ideas; It's Initiative They Lack," drew heavily from Robert's study of commercial innovation from university faculty.

After 10 years with Burns and Roe, **Dominick Fortunato** has joined Valcor Engineering in Springfield, N.J., as a senior staff engineer reporting to the president. Valcor is a leading manufacturer of solenoid-operated valves, and Dominick will be organizing and coordinating all development activities for the company. Congratulations are also in order on Dominick's recovery from a mild heart attack.

We have word from **James Cunningham** that he is vice president for product research at Docutel Corp. and finds the automated teller business exciting. He and the family are quite enthusiastic about Dallas.

Donald Jassowski has been with Aerojet-General for 23 years. He managed the engineering laboratories for 18 years. Currently they're developing a coal gasification test facility. Donald has been married 22 years to Marilyn and they've three children: Marjorie, Michael, and Nancy, ages 18, 16 and 14.

Jordan Gruzen and Partners are relocating to 11 West 42 Street in New York. There goes that neighborhood!

Enjoy these last days of summer — **Fred Morefield**, Secretary, Shared Medical Systems, 650 Park Ave., King of Prussia, PA 19406

61 20th Reunion

A whole bunch of familiar names appear in this month's column. It's always good to hear from old names but you people who have been quiet over the last year must come to the column's rescue. Send in a line and see your name in print!

Two of the class stars have been in the news recently. **Gerry Wilson**, who heads the M.I.T. electrical engineering department, was just elected to the National Academy of Engineering Sciences, a very high honor indeed. He was elected for his contributions to the design and control of electrical power systems under emergency conditions. Congratulations, Gerry.

John Deutch, who was on leave from M.I.T., where he was head of the chemistry department, is back. He had been an under-secretary in the Department of Energy since 1979 but had been in Washington in various energy-related capacities since 1977. John's interests in Washington have not completely gone by, however. He has been appointed to the Nuclear Safety Oversight Committee which will monitor the activities of the nuclear industry and the Nuclear Regulatory Commission.

Other luminaries in the class include **Angelo Lamola**, quite well known in the field of photochemistry and photobiology, who has been promoted to become the head of molecular biophysics research at Bell Labs in Murray Hill, N.J. He and his wife, Sandra, live in Warren, N.J., with their two children Lenna and Steven. . . . **Joe Harrington** is moving up, too. He is now chief Mechanical Engineer for the New England Power Service Co. His department is concerned with keeping oil-fired and hydro-electric power plants running and converting the oil-fired plants back to coal whenever possible. Joe has also served on an M.I.T. Visiting Committee in humanities and is now taking on some educational council responsibilities, too.

Grady Harris has moved up to vice president of research and development at Baxter Travanol Labs, Inc., which is in the specialty products for hospitals field.

Pete Buckner has grown a beard and looks very handsome indeed. In addition he has become manager of planning for Boise Cascade's Specialty Products Division in Brattleboro, Vt. After work Pete is president of the board of directors of the Homer Thomas School in Guilford and the chairman of the finance committee of the Chelsea House Folklore Center.

Remember the amazin' **Bernie Goldhirsh** who has been starting successful magazines for the last couple of years? Well the "flagship" magazine in his fleet, *Sail*, has been sold to the Meredith Corp. in Des Moines. Bernie has been quoted as saying, "Some people are destined to create things and others are better suited to manage them." He has also sold two other successful ventures: *Motor Boat* and *Marine Business*. That leaves *Inc.* magazine in his portfolio.

Peter Gaposhkin writes that he has "started working for Informatics at Pames Research Center. My present job involves processing telemetry data from *Pioneer* 10 and 11 and computing temperature, velocity, and density from the data using a least-squares program."

And, finally, **William Jouris** writes that "our family is still enjoying our stay in Saudi Arabia. I recently traveled to New Zealand during my annual leave to participate in a group making an under-water documentary in the Poor Knight Islands. The project I came here to participate in four years ago is still not complete so I may be here for another two years. Regards to all my classmates." Thanks for the letter, Bill.

Remember that our 20th Reunion will be coming up next June. **Tom Hastings** has been making rumblings about getting a committee together and you should be inundated with mailings soon enough. — **Andrew Braun**, Secretary, 464 Heath Street, Chestnut Hill, MA 02167

62

I received only three short communications for this issue. If you are reading this and have not corresponded in recent history, please be seized by pangs of guilt and grab a pencil and paper. Just tell me where you live and write a sentence or two describing your family, job, hobbies, or whatever you like.

An old friend **George Meyer** writes that he has recently been promoted to colonel in the U.S. Air Force and will soon be chief of medicine at Wright-Patterson Air Force Base in Dayton, Ohio. He invites anyone passing through to look him up. . . . **Henry McCarl** is currently chairman of the Birmingham (Alabama) Planning Commission and is serving as a member of the board of directors of the Society of Mining Engineers of AIME. . . . **F. Kaye Porter** writes that she is in graduate school in physics at the University of California at Santa Cruz. . . . Now that you've finished reading this write me a short note. — **John E. Prussing**, Secretary, 2106 Grange Dr., Urbana, IL 61801

63

Barbara and I are planning our July backpacking trips to the Sierras. We will spend five days around the first part of the month in the mountains just north of Mount Whitney and then visit the same area for eight days later in the month. Our trips are usually very leisurely; we don't try to cover too much ground. Instead we spend our time in more sedentary activities — fishing, reading, sleeping late, and watching an occasional cloud float by in the clear Sierran sky. The mountains have a theraputic effect on us and are a welcome change from our usual hustling, bustling, daily schedules.

Bob Yaes will be delivering therapy this summer, rather than receiving it. He has been studying medicine at Memorial University of Newfoundland in Canada. Bob received his M.D. degree on May 31 and began residency in radiation therapy at Memorial Sloan-Kettering Cancer Center in New York on July 1. He says that, ". . . it isn't what I intended to do when I studied physics at the Institute, but it beats working as a room service clerk at a hotel." Amen.

Bob Petrich is still living in Cannes, France, and now is European region R & D manager for industrial chemicals and plastics for Rohm and Haas Co. His wife Pat and their three children, ages 7, 9, and 14, are continuing to enjoy the overseas experience.

That's all there is folks. If I don't get some letters from you, I'm going to have to fill space here with lies about my fishing exploits. — **Mike Bertin**, Secretary, 18022 Gillman St., Irvine, CA 92715

64

James Suhrer Dorr has been promoted to editor from chief technical writer at WRUBEL Computing Center at Indiana University. Jim says "as a consequence, my red-haired belly dancer wife and I have bought a house," closing it on St. Valentine's Day.

Marlene and **David Sheena** are living in Newton, Mass., with their two children, Jonathan and Deborah. David is engineering manager for Gulf & Western's Applied Science Laboratories in Waltham, Mass. While my wife (Marlene Schlosser, often the author of this column) was in Boston last October at the Women's American ORT National Convention, she met Marlene Sheena who is quite active in the New England Region of ORT and was on the Convention Planning Committee.

I completed a ten-day stint in California, visiting such places as Oxnard, Los Angeles (Culver City, actually), and San Diego, all of which currently have ManTech offices. George and Lewis were dropped off at the "sleep-away" camp to experience that level of fun and independence for the first time. I'm confident they will enjoy themselves, but I'm not sure their mother will survive her anxieties. In any event, we could only get two weeks worth this year, so it will undoubtedly be a comfortable experiment all around. Later this summer we'll be taking a summer odyssey. Using one of those "fly anywhere in our route system for 21 days for one price" deals (Delta, if I can advertise for them), we'll be stopping in Los Angeles and San Diego (business for me, fun for Marlene and the kids), Boston (family and old, dear friends), and Bermuda (forever Marlene's favorite place; for me the vacation leg of this sojourn). It, too has become a place with a few dear friends because of the number of times we've visited.

We all hope this summer held pleasant and interesting events and activities for all of you and your families. Stay well and *please* write! — **Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, MD 20854

65

Ed Hoffer walked over the other night with the secretary's files and the guard is changed. Those of you who liked the early seventies will love the early eighties. Neither Ed nor I have very good notes from the reunion, as we were both mostly elsewhere, but I'll print what we have and then go on to this month's notes and clippings.

The 15th reunion followed the format established for the 10th: wine and cheese Friday night, cookout and swimming Saturday afternoon, dinner dance Saturday night. Ed hosted a get-together Sunday at his place on the Cape. **Frank Mechura** beat all hands at the swimming race at the Alumni Pool Saturday.

Tricia Carr Erikson is now living in the Bay Area with her nine-year-old son Arvid. Tricia works as a financial analyst for the Bank of America. . . . **Jesse Lipcon** lives in Harvard (Mass.) with his wife Lynne and two-year-old son Scott. Jesse is very happy in his senior technical position with DEC. . . . **Jim Steele** lives in California with wife Linda and two youngsters. Jim works for Foxboro Corp.

Howie Ellis and his wife Jean brought their two-month-old daughter, their second youngster, to the reunion. Howie's environmental consulting firm in New Jersey is still going strong. . . . **Billy Cohen** is living in California, divorced, and has one son. . . . **Mike Oppenheimer** and his brother own two Ben Franklin variety stores in Florida and are looking to open a third. Mike is still single and looking for the perfect woman.

Other notes from people who weren't at the reunion (or who Ed and I didn't see): **Don Coulter** worked on the construction of the new Rio de Janeiro International Airport and is now with Construtora Norberto Odebrecht, a Brazilian civil contractor, working to obtain new contracts in South America, Africa, and the Middle East. . . . **Ralph Cicerone** was hoping to make the reunion but had to be at M.I.T. the previous week for a Ph.D. examination and then return to San Diego, and seemed a bit daunted by two round trips to Boston in two weeks. . . . **Pier Oddone** reported the birth of a son, Gian Michele, in July of 1979. . . . **Barry Wessler** has been appointed vice president of GTE Telenet's private network group. . . . **Gerald Katz** has been named assistant executive director of Medical Affiars at the Kennedy Memorial Hospital for Children in Brighton.

Finally, some big personal news from your secretary: On May 10 I was married to the former Anne Spiegel Wood. Anne is the director of finance and administration of the Sloan School and received her S.M. there in 1977. Anne has three children — Rebecca, 10, Elizabeth, 8, and John, 5, so I'm getting a lesson in instant family. We live in Anne's big old house in Wellesley with a cat and goldfish. Department of pure coincidence: We're about three blocks from Ed Hoffer.

Finally a word of thanks to **Ed Hoffer**. He did a super job as secretary and I plan to turn this column back over to him in five more years, if he's willing. Until then, its good to be back. — **Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

66 15th Reunion

The time is rapidly approaching for our 15th Reunion. Be sure to mark June on your calendars and prepare for a grand time. **Stu Vidockler** will be coordinating the activities.

I was sorry to learn of the passing away of **Alfred Stone**. He had been living in Milton, Mass.

Congratulations to **Dennis Overbye** on being the 1980 journalist winner of the American Institute of Physics — United States Steel Foundation Science Writing Award in Physics and Astronomy. His article was "The Wizard of Time and Space," and appeared in *Omni*, February, 1979. Dennis left academia for good to take up writing after a year of graduate school at U.C.L.A. in astronomy. Currently, he is an editor of *Sky and Telescope* magazine.

Richard Waterhouse is director of research and development at Systems Architects, Inc., in Randolph, Mass. He designed and coordinated the development of the PASS (Procurement Automated Source System) described in *Nation's Business* (April, 1979) for the SBA. This is a computer based system used by a number of government departments for locating small businesses having specified capabilities.

Isaac Bornstein is continuing his studenthood at the Univeristy of California-San Diego medical school. Isaac began this training in 1978 after having earned a Ph.D. from Berkeley in nuclear engineering and working with the Navy and the Veterans Administraion. He plans to follow medical school with a radiology residency in San Diego. . . . **Judith A. Perrolle** writes that she is now an assistant professor of rural sociology at the University of Missouri, Columbia, and **Morton J. Cowan** is an assistant professor of pediatric immunology at University of California at San Francisco. Morton lives in Marin County with his wife, Edie, and their two children, Brooke and Zachary.

David Liroff now performs the functions of broadcast manager at the WGBH-TV station in Boston, Mass. He is leading the wave of change in TV as the cost of broadcasting drops with increased satellite transmission. The reduced cost facilitates specialized programming and eliminates the need for broadcasters to aim solely at the general audience. Dave plays a very definite role in WGBH, leading the Public Broadcasting Service (PBS) distribution of programs. WGBH is responsible for nearly a third of the distributed PBS prime time programs.

Richard Cutter returned to Boston last year as an associate of I.M. Pei & Partners, Architects, to supervise the construction of the new addition and alterations at the Museum of Fine Arts. He spent most of the 70's working on the new East Building of the National Gallery of Art in Washington, D.C. (Congratulations! That job was well done!). . . . **Nicholas Negroponte** was also graduated in architecture and has gained an international reputation in the area of interactive computer graphics while serving in the M.I.T. Department of Architecture. Nicholas started as an instructor at M.I.T. in 1967 and now holds an associate professorship.

Chester L. Balestra is presently a member of the technical staff of Texas Instruments' Corporate Research Laboratories in Dallas. He has three boys ranging from ages 1 to 11. . . . **Robert L. Silver** reports his second child, Stephanie, was born last year in November. . . . **Paul Liao** continues to do research in nonlinear optics and laser spectroscopy at Bell Labs in Holmdel, N.J. He has two daughters, Tracey, 9, and Joey, 7. On the other side, Paul is first officer of his local sailing club that calls itself "River Rats."

Remember the 15th Reunion coming up. Best wishes — **Joe Patterson**, Secretary, 1403 Gerard St., Rockville, MD 20850

67

Bob Howard stayed with us for a few days in June during a brief California vacation. Bob lives in Miami and has kept busy as always with a wide variety of activities, including computer consulting, building single-family homes, managing an answering service, and involvement in a municipal bond company. . . . **Jim Cronburg** received his second degree from M.I.T. last year, this time in architecture, and is now in the Planning Office at M.I.T., where he has been working on video in architecture. He is also finishing a video contract on a renovation project with a local bank. Jim is active in the M.I.T. Choral Society. . . . **Alan Gevins** reports that his research on the mass electrical activity of the human brain is proceeding very well. His position is still director, EEG Systems Laboratory, University of California School of Medicine, San Francisco. . . . **Alfonso Falco** is working for Boeing as a structural designer on wind turbine systems. . . . **Rod Peterson** switched jobs recently and is now an engineer with NASA at the Langley Research Center where he is involved in wind tunnel model design. The Petersons have a son, 6, and a girl, 4. . . . **Steve Braunstein** is an advisory programmer at IBM. He is married to an attorney, Jill Casper, Vassar, '68. They live in San Jose, Calif., with their son Timothy, born September 29, 1979. . . . **John Asbeck** has been appointed assistant plant manger of Cyanamid Agricultural de Puerto Rico, Inc. He and his wife Magdalena are living in Dorado, Puerto Rico. — **Jim Swanson**, Secretary, 878 Hoffman Ter., Los Altos, CA 94022

69

Just got back from the American Booksellers Association Convention in Chicago where I was trying to publicize *The Silver Mistress*, which I'll be publishing in the fall. One thousand miles in 19½ hours, and no speeding tickets — not too bad, but a little tiring.

Gary Semanision has been working on seismic data at a computer center in Calgary, Alberta, for the last few years. Attending graduate classes at night, he hopes to do his M.S. thesis at the University of Calgary in 1981. This summer he's examining sedimentation in the Fraser River Delta and adjacent coastlines.

Currently serving as "Chief, Flight Technical Program Branch" at the Office of Flight Operations, FAA Headquarters, is **Thomas Imrich**. Besides also serving as chairman of FAA's Flight Standardization Board for the new B757/B767 aircraft he still coaches 8 and 9-year-olds in the local soccer league while his wife Dee is a Cub Scout Den Mother. . . . **Claudia (Winters) Viehland** is a chemistry teacher at Chaminade College Preparatory School in St. Louis while husband **Larry** is a tenured associate professor at Parks College of St. Louis Univeristy. They report that **John Schaeffer** will be joining the Parks College faculty in September, 1980.

Finally coming through with his promise to write is **Bob McGregor**. In 1978 he started a management/market consulting business, which provides business planning services to high technology companies, and also set up a personnel placement service for managers, engineers and scientists, all under the name of Technology Marketing International. Bob and his wife Beth are still very active in the singing and stage performing circuit and have a beautiful 2-year-old daughter Amanda.

On the staff at the Cleveland Clinic in general surgery is **Sharon Grundfest Bromatowski**, M.D. Her husband Michael is a French otolaryngologist who is working at Case Western Reserve University. . . . Besides a full time job as legislative aide to the Mass. State Senate's Human Service Committee Chairman, **Bob Schaeffer** also keeps busy editing and teaching at the Policy Training Center in Cambridge. . . . **Michael Rodriguez** sent the enigmatic message that he is "making progress in decoding signals from deep inner space (the brain)."

After five years on the faculty at the Business School at Columbia, **Michael J. Ginzberg** has resigned to join the faculty at New York Univeristy. Seems that Columbia is not yet sure if computers are here to stay, while N.Y.U. is actively involved in research in the information systems area. . . . Mary and **Edward Gruhl** moved to New Hampshire last year with their four boys. . . . **Robert Listfield** has been appointed vice president, head of planning, at the Federal Reserve Bank in Boston.

Finally, **Albert Sawyer** is a member of the circuits and maintenance group in the TSPS Hardware Design and Automatic Intercept System Department at Bell Laboratories where he has been working since 1975, after having spent five years with Western Electric.

Keep sending in those cards and notes. — **Robert K. Weiner**, Secretary, Box 27, M.I.T. Branch, Cambridge, MA 02139

70

This is the first opportunity to report to you about the 10th Reunion events. The Committee's efforts were evidenced by the large list of interested classmates. However, attendance at the various events was mixed. **Joe Baron** traveled from Taiwan and was seen around the tennis courts with **Bob McKinley**, **Manny Weiss** and others. Joe is president of President Skate Products, Inc. Bob McKinley is involved in tennis instruction and a club on the South Shore. **Pete McCall** came from California. **Carl Yankowski** visited for the weekend with his wife, Patricia. Maggie and I were combining business with pleasure and did talk to as many classmates as we could. I am sure the lines of communication will reveal other news.

The regular mail had several items. **John Eichelberger** is in Albuquerque with the Geophysics Research Division of Saudia National Laboratories, while Alice is a student at University of New Mexico. . . . **Ronald Polinsky** is continuing his stay at the National Institute of Mental Health to continue research on neuro-pharmacology. He and his wife had their third child, Stephanie. . . . **John Holding** is director of marketing for the Chicago Board of Trade and is involved with Maureen in the theatre. Anne and **Chris Cross** own Sun Energy in Pittsfield and are involved in all aspects of solar and woodburning energy systems. — **Robert O. Vegeler**, Secretary, Kennerk, Dumas, Burke and Backs, 2120 Ft. Wayne Natl. Bk. Bldg., Ft. Wayne, IN 46802

71 10th Reunion

From the Festhalle in Munich **Fred Horr** writes that spring has arrived, the frauleins are beautiful and the beer gardens are where life in Munich

begins. Joining him is that honorary member of the Class, **Stu Johnson**, who says he will still tutor anyone in '71, whether in Paris or Munich or anywhere. . . . **Robert Deich** is on the staff at Frederick Cancer Center in Frederick, Md. . . . **Bob Lidral** has finally left the world of academia for Control Data in Boston. He reports he is chasing after the seldom achieved state of solvency and attending a lot of conventions. . . . **Jack Hiatt**'s new home was featured in the *Bethel* (Conn.) *Home News*. The home is very pretty. The article mentioned that Jack is with N.C.S.S. as their product manager at the company's Wilton office, that his wife, Patty, was expecting a child; and that they have purchased a small corner shopping center in Westport where the both work part-time.

Every time I write these notes, I am tempted to include something about the activities of my son. It is amazing how a subject that was once so boring becomes very interesting and exciting when you finally become a parent. — **Hal Moorman**, Secretary, P.O. Box 1808, Brenham, TX 77833

72

Spring has changed to summer and New Yorkers are clearing out to their summer houses as I write this column. Many of our classmates are also on the move, onward and upward in their careers.

Carliss Young Baldwin, an assistant professor of finance at the Sloan School of Management, has been appointed a 1980-81 faculty fellow at the Mary Ingraham Bunting Institute of Radcliffe College. She is one of 28 scholars, artists, and writers designated fellows and research associates at the Bunting Institute. She is one of four faculty fellows. She will be able to devote full time to her scholarly project "Irreversible Investment Decisions — Theory and Practice."

Joe. C. Litten has been appointed Vice-President, Public Finance, at Dean Witter Reynolds, in San Francisco. . . . **William De Peitro** will be appointed Assistant Professor of Dermatology at Columbia University, College of Physicians and Surgeons as of July, 1980. . . . **Charles E. Mann** has joined the Washington, D.C. office of Dames & Moore, engineering and environmental consultants, as an associate. As a coal economics specialist, he will market Dames & Moore's broad-based energy fuels management services to industrial companies and electric utilities, and will offer planning and market forecasting services to mining companies. Charlie went to the job after most recently serving as Director of Coal Studies for Energy and Environmental Analysis, Inc.

Glenn Rowsam sent a long note catching up from graduation to now: "After a year in Boston driving a cab, and after six years living in the San Francisco Bay area (working as an encyclopedia salesman, a solvent-delivery truck driver, a mail handler for the U.S. Postal Service, a math tutor, and an office clerk in a wholesale egg warehouse, among other things), I finally got serious, and am now working as a computer programmer for the New York Department of Social Services in Albany. For the first time — a job that pays me for doing something I like! Should have tried it earlier (he said belatedly)." He didn't mention what brought him back east from the Bay area.

Moving on to the family department, **Ken Wiltsee** reports that he and his wife, **Kerrie Osborne**, recently had a daughter, Katelyn Thompson. He is presently head of modeling applications with GCA/Technology Division in Bedford, Mass. . . . **Jerry S. Greer** reports that in February, 1980, his first child and son, Jared Scott Greer, was born. This followed his June, 1979, receipt of a S.M. in Management from the Sloan School and August, 1979, move to Andover, Mass. After graduation, he rejoined Chas. T. Main, Inc., as a project manager.

For myself, I'm still practicing law in New York and looking forward to spending many summer weekends on a beach or in Vermont. I hope that the fall will bring news from many of you. In the meantime, have a great summer and fall. — **Wendy Elaine Erb**, Co-secretary, 531 Main St., Apt. 714, New York, NY 10044

73

Daniel Dern reports that his status as an employee is out in favor of being his own boss in the computerwriting biz. Presently doing articles, features, etc., Dan has also written folk music reviews for over two dozen places, liner notes for an album, and has performed in Little Carnegie Hall. In his spare time he's studying American sign language and planning to sell contact lenses for chickens (sorry, folks, but some of these you've got to quote verbatim!). . . . **Jeffrey Seltzer** will be staying another two years as a cardiology fellow at Boston University, then "heading south."

Martin Rosenberg, who shares my noted disgust at the letters from M.D.ed fellow classmates, injects some variety; he M.A.ed and Ph.D.ed at Penn, in the history of art. He is now at U. of Tulsa as an assistant professor of art history. In the meantime he and Ellen have produced Matthew F. ('01) on 9th December, 1979. . . . Joseph Folk (EE, '72) recently promoted to assistant vice president of Consolidated Rail Corp. of Philadelphia.

John Di Loreto '74 was appointed regional sales development manager at Intel. He enjoys living in Palo Alto. John also owns a recording business, which is picking up beyond his expected goals.

And . . . would you believe, after all these years of thinking we were both mythical beasts, Tony Scandora '75 on 9th August and yours truly on 16th August (a mere week apart) will happily marry our respective lasses (Kathy Tate and Ruth De Pasquale), and sing at each other's weddings. Pictures will follow, no doubt. In addition, I'll be assuming the parenthood of youthful Eric ('96 — *and* a planned Phi Delt, of course!) — **Robert M. O. Sutton**, Secretary, (write care of Technology Review)

74

Here we are again: all of us avidly reading these notes to find out if our classmates are having more fun (or less) and "getting ahead," while I am definitely getting behind.

Harvey Michaels writes: "After rising to the position of assistant director of planning at the Massachusetts Energy Office, I entered the field of energy consulting at Xenergy in Lexington (Mass.) All is well, and Amy and I are expecting our first child this summer."

Gulf Oil Corp. and **David N. Tso** are working well together. David writes that he has been transferred from Pittsburgh, where he was director of system and affiliates crude supply, to Houston where he has become director of crude oil trading.

Ludwig Chang has been promoted to second vice president at Chase Manhattan Bank, N.Y. Nice work. He is clearly doing the right things. Ludwig: I am coming to New York to see what it is that you do. . . . **Denis Perlman** writes: "I am presently engaged in designing a solar greenhouse to be added on to a 100-year-old Victorian house in Amherst, Mass., to provide two-thirds of our heating needs and to expand the Silverscape Cafe, a natural foods restaurant where people will enjoy the benefits of solar. I've been goldsmithing here at Silverscape designs since 1976. All M.I.T. folk are welcome to view the project and make suggestions." Now that's an invitation I will definitely accept.

Alan Steinberg is the engineering program manager for Amecom Division of Litton Industries, College Park, Md., responsible for all aspects of design and development of advanced-technology digital signal analysis systems. He had designed several real-time, in-depth collection and analysis systems for processing radar, telemetry, communications, and acoustic signal data.

Barry N. Nelson writes (a lot): "I received my Ph.D. in chemical physics last November and have embarked on a new, more exciting, field — research and development on fine-line photolithography for large-scale integrated circuits at Bell Laboratories in Allentown, Pa. My wife Linda is director of clinical services at Children's Hospital of Philadelphia and is an assistant professor of pedodontics at the University of Pennsylvania. We recently bought a house and we both have to drive an hour each way to work. Ugh!!". Ugh.

Ben Svetitsky writes from Berkeley: "I defended my Ph.D. thesis in theoretical physics at Princeton last November, and since then I have been employed as a post-doc in the group in which I did my thesis research at the Stanford Linear Accelerator Center. In September we (Ed: Ben has clearly attracted some free electrons into his relatively stable field at SLAC) move to Santa Barbara, where I have a two-year postdoctoral position at the Institute for Theoretical Physics on the University of California campus."

Holly K. Horton writes that she left her job as a geologist for Utah International, Inc., to graduate work at Stanford University in exploration geophysics. She is interning at Chevron in San Francisco this summer and then back to Stanford in the fall. She reports a "pleasant suprise": many M.I.T. grads are out there.

A few words from **Patty Newbold**, who probably doesn't remember that I have some pictures that I took of her when she, **Dennis Dickstein** (this plug is not paid for), and I worked on a project to study the ins and outs of infrared film photography: "Since August, 1979, I have been working as an independent program evaluation and planning consultant in Pittsburgh. **Rod Gretlein** (my husband) is nearing completion of his Ph.D. in game theory and will be looking for an academic position next year." Patty asks, "How come there's almost never any news from our old friends in Senior House in *Technology Review*?" and I respond that I am dependent on notes scrawled on the backs of Alumni fund contribution envelopes (not a single letter from anyone!). My recollection of Senior House people in the period 1970-74 is that they are not the kind of people who would be sending money to a large educational institution with rather strong ties to the military research establishment. If I am wrong, I hope that you Senior House folks will write and tell me. I promise to submit your letters in full to the *Review* but I can't guarantee that they won't edit the copy. (Don't worry, Patty; the film is safe with me.)

Rory J. Albert has been an associate with the New York law firm of Pruskauer, Rose, Goetz, and Mendelsohn for the past three years. . . . **Paul Schindler** is the author of a guest column in the March 14 issue of *The Tech*, on the neccessity for balance in one's life. (Paul may not remember that I was the happy face with the inordinately long hair and the cue cards and the "voice" on the very first MITV newscast which he anchored. Those were some good days.)

Since my pre-release rumor, the official announcement has come: **John P. Tierney** is assistant vice president and associate actuary in the Personal Lines Actuarial Group at Commercial Union Assurance Companies of Boston. Many of you may remember John from intramural hockey: he was the 110-pound high scorer who, when checked against the boards by the 200-pound opposing center, would mutter, "Some day I am going to set your rates, buddy." At last, the large center would fall down on the ice and feign extreme pain from a wallet injury. John also received the most penalty minutes of anyone on the team for the entire time he played intramurals.

And now, in keeping with the tradition of reporting late-breaking, up-to-the-minute news, I am happy to note that **Dean Angelos** was married to Deborah Keyes of Wellesley on June 2, 1979. It's been a long honeymoon.

Thomas Texeira wrote that he was completing work on a Ph.D. in Computer Science at M.I.T. in June. . . . **Joe Walkush** and his wife Mary have just had their second child, Megan; Joe is attending Stanford Business School. . . . **Chris Demain** is working as manager of corporate planning at Gould, Inc. in Rolling Meadows, Ill. He and Joyce (Lerner) Demain (M.I.T. '75) had their second son, Seth Eric, on September 16th, 1979. . . . We hear that **Randy Adams** has just been married. Randy, would you please mail in more details.

John G. DeLuca received his Ph.D. in toxicology from M.I.T. in January and is now a post-doctoral fellow at Sidney Farber Cancer Institute in Boston. He and Virginia have a new son, John Vincent, born on February 11. (a very auspicious

day: it is also my birthday). . . . **Norman Mazer** writes that he received a Ph.D. in physics from M.I.T. and an M.D. from Harvard Medical School in 1978 and since then has been working as an intern and resident in medicine at Peter Bent Brigham Hospital while conducting biophysics research at M.I.T. . . . **Ed Montes** is currently working for Scientific Time Sharing as an applications consultant, "having a ball. . ." .

From **Henry Joseph**, as a contributor to the Alumni Fund, a note that I have saved for last because I think we all might give it some thought: "After a number of years making a living as a carpenter, I am now working for a non-profit community organization in Cambridge. We are expecting a real struggle with M.I.T. in the next year over the development of the "Simplex" land and other property owned by the Institute on the edge of our neighborhood." What responsibilities does a corporation have to the community in which it flourishes?

To the outgoing secretary of the class of 1975 (see below): you did a terrific job, Jenny. And if you all want to make me work as hard as she worked, write to me, or Lionel. — Co-secretaries: **Jim Gokhale**, 12 Pond Lane, Arlington, MA 02174; **Lionel Goulet**, 34 Tremlett St., Dorchester, MA 02124

75

On the evening of June 6 dozens of people converged on Cambridge, Mass. to witness a bizarre pagan ritual. No, not the usual academic rites of spring but rather the fifth reunion of the class of '75.

Those of you who did not show up will never know exactly what you missed, but I'll do my best to fill you in. The celebrations began on Friday with a party on the sixth floor of the Sloan Building. While admiring the many sailboats that crisscrossed the Charles River, I chatted with **Bob Graber**, up from Alexandria, Va. Bob worked as an economist for a while but is now a financial analyst with the Securities and Exchange Commission. In addition, he is working on a Master's degree in Economics at Virginia Tech. Later, as the sun began to set, I talked to **Richard J. McCarthy**, who lives in Framingham, Mass., and works as a consultant at Arthur D. Little in the energy area. Incidentally Rich was one of the main organizers of this reunion, and he has accepted full responsibility, though not the blame. **Duane Finello** told me about his studies first at Georgia Tech and now at the University of Texas at Austin where he is working hard to finish his Ph.D. dissertation. Another within a few Angstroms of getting a Ph.D. is **Jennifer Gordon**; she is at M.I.T. in the Nutrition and Food Sciences Department (her laboratory is in the basement of Building 16), and she may well finish during the next year. **Dave Lockwood** introduced himself and when I asked him about tiddlywinks he gave me a brief demonstration of his skills right there on the carpet. Dave could have been in New Zealand that weekend but decided to pass it up in order to come to the reunion. I also talked with **Anita Horton**, who lives in Europe (Luxembourg); in spite of the distance she has done a great job as our class president for the past five years. I met a fellow Cantabrigian in the person of **Diane Gilbert**, who works at Arthur D. Little in the bio-enviro-sciences area.

After refilling my glass of wine I talked with **Lydia Talmers**, who is now in New York but has been all over the map these past few years, having lived in Dacca and various other exotic cities. She looks forward to going overseas again soon, perhaps to Saudi Arabia.

Eight a.m. the next day. The sky: cloudy. Busses take us to a pier in Boston; a light drizzle begins to fall as we board the *Vineyard Green*. Our destination: George's Island, in the middle of Boston Harbor. It is labelled as a picnic, but the outing turns out to be a test of endurance and survival as well. Although the rain has stopped when we set foot on the island, it soon picks up again in a steady downpour. **Charles Fendrock**, our resident pyrotechnic engineer, manages to get the charcoal stoves going. Unfortunately an unexpected shortage of fresh water on the island makes cooking clams and corn problematical. Rainwater, seawater, and beer are suggested as substitutes but **Dave Lockwood** shows off his technological know-how by hitting upon a better solution: melting down large quantities of ice cubes over a stove. Cooking gets under way. **Rich McCarthy** earns the honorary title of burger king for his accomplishments on the grille. To minimize the effects of a cool wind we huddle in small groups, guzzling beer and munching munchies. Some of us play wet frisbee while others go off to explore Fort Walker, a fortified structure built on the island in the mid-19th century to defend Boston Harbor. At about 3:30 the rain has died down and we board the boat to the mainland.

I thought the reception at Endicott House on Saturday night was the best part of the reunion program. This beautiful mansion was at one time discussed as the residence of the governor of Massachusetts, but it is now owned by M.I.T. My companions at the dinner table included:

Bert Halstead, whom I remembered from my days in course VI; Bert took his Ph.D. a year ago and is now an assistant professor at the Institute. We did not discuss E.E.

Sherman Wang works in Riyadh, Saudi Arabia, for Raytheon; he finds it a tough environment but manages to survive quite well thanks in part to frequent trips out of the country.

Andrij Neczwid is in Chicago with Motorola; currently he is working on a simulation of a communications system.

After dinner the class met to elect its officers. **Ed McCabe** noted that the outgoing officers, **Anita Horton** (president) and **Jennifer Gordon** (secretary/treasurer) had done an outstanding job and should be reelected. The audience was enthusiastic about this proposal but unfortunately the two incumbents were not. After a brief campaign a ballot was held and the following new officers were elected: **Rich McCarthy**, president, **Charles Fendrock**, treasurer and **Alex Castaldo**, secretary.

Music, dancing, and conversation continued well into the night, with our very own DJ **John Kraut** at the controls and spinning the tunes.

One odd incident: Dave Lockwood accidentally became locked in one of the scores of rooms of Endicott House. It seems that the locking mechanism of the door failed when the door was closed. Once again Dave's technical skills saved the day: he managed to take the door off its hinges from the inside and so escape to freedom.

More gossip from the party: **Jan Pinkowish** finished an S.M. in chemical engineering and works for Rohm and Haas. Initially he did process design work but recently he has been assigned to the marketing area in a newly formed division of the company which makes ultrafiltration membranes for the electronics industry. **Steve Ralston** is an account executive (i.e. broker) at Merrill Lynch in Baltimore, Md. Being relatively new to the area he hasn't yet met many M.I.T. alumni there; you may want to look him up. **Storm Kauffman** lives in Arlington, Va.; he became a registered professional engineer this February. Arlington is also the home of **Jim Moody**, a lawyer and retired Baker House politician. **John Krout** also lives in Arlington.

Other alumni who attended the reunion (based on Alumni Association data and not including a few last-minute additions and cancellations): K. Armstead '78, **G. Babecki**, **F. Bercher**, **M. Callaway**, **S. Chapman**, **H. W. Chin**, **J. N. Dehn**, **L. Giles**, **H. Gustin**, **M. Hainsworth**, **G. Harris**, **A. Horton**, **J. Jones**, **P. Jorgensen**, **S. Krasner**, **J. Laskey**, **D. Leep**, **P. Lieberman**, **A. Pankow**, **N. Preyer**, **R. Sadock**, **R. Shafer**, **K. Stahl**, **D. Strauss**, **W. Sung**, T. Teixeira '74, **W. Van Lierop**, **D. Wargo**, **A. Weltge**, **R. Withers**, **J. Wrinn**.

That's all for now, folks. — **Alex Castaldo**, Secretary, 929 Massachusetts Ave., (12D), Cambridge MA 02139

76 5th Reunion

I regret to report the death of **Benjamin Laufer** on September 28, 1979. He was in math and physics, and our condolences go out to his parents.

Clyde Mitchell sends word that he in now an associate with Sherman and Sterling, a law firm on Wall Street. (He finished the University of Virginia Law School in June, 1979). In April, the *American Bankruptcy Law Journal* published an article of his entitled: "Securities Regulation in Bankruptcy Reorganizations."

Philip Giangarra, a crony of mine from our glee club days, has finally written. He married Barbara Richardt in 1978, and they have one child, David, born May, 1979. He changed jobs from NUSC, Newport, to Codex, Mansfield, Mass. He's still playing table tennis and singing with the Poloquin Chorale in Providence and training for a 100 mile bicycle race in September.

Jon Maybaum has gotten his Ph.D. in pharmaceutical chemistry from the University of California, San Francisco. He is now in a post doctoral program at George Washington University Medical Center, Department of Pharmacology, in Washington, D.C.

Gretchen Megowen got her M.D. from Tufts in July and has begun a four-year psychiatric residency at Timberlawn Psychiatric Hospital in Dallas. . . . **Alan Levin** has graduated from Sloan and is continuing to work for the computer/consulting dynamics division of Interactive Data Corp. He and his wife Marla bought a house in Natick, Mass., last September. "Overall we are quite happy and doing well." . . . **Sue Sweigert** is now in grad school at the University of California at Berkeley, in biophysics. She expects to finish in June, 1982. "I've gotten quite involved in the Graduate Assembly, where I ran into **Larry Hurdy** and **Marsha LaVoie** and serve on a couple of committees with Jerry Epstein, '78. Seems like one can't get away from M.I.T. even by moving to California."

Mike Neff is currently working on his Sc.D. thesis in Course III. Some of his research will be done in California, at Stoody, Co., as part of the M.I.T. doctoral research in-absentia program. . . . I have a lovely postcard from **Dan Dershowitz** and Debby Gross, '78, featuring the skyline of the San Francisco financial district. "San Francisco is lovely. We're staying with Mike Sarfatti, who lives on Telegraph Hill near the wharf, Chinatown, etc. . . . we walked through Chinatown, took the cablecar to the wharf and a boat around the bay."

In speaking with **Jeff Baerman**, I learned that he is leaving Chicago for an internship at Barns Hospital, St. Louis, Mo. He has finally achieved an important goal — he broke the four-minute, ten-second mile and is now considering retiring his running shoes. . . . Ricky Farber ('77) and I have gotten together several times, as he lives only ten minutes from me in SoHo. He is working as an actuary for Coopers and Lybrand, one of the "Big 8" accounting firms, and enjoys it alot. . . . **Erland van Lidth de Jeude** also lives within 20 minutes of me. He is currently trying to land another movie role and is doing some computer consulting on the side. . . . **Mike Sarfatti** passed along a rumor to the effect that **Dave Rosenthal** is doing geological research in the badlands of Oklahoma, looking for oil. And Marla Eglowstein, '79 called to tell me that she has been elected a vice president of the Stein Club in Boston.

As for your secretary, he is settling comfortably into Greenwich Village. The atmosphere is a bit strange at times for an unrepentant Bostonian, but lively enough to make up for when the commodity futures markets are closed. Speaking of which, the short and long term interest rate futures markets have risen from the dead and displayed surges which are prematurely greying some corporate bond people I have met. We have also been seeing some simply wild times in coffee and sugar (but not in cream!). On a serious note, your secretary is enjoying his new job immensely. I am the only American employee, and find the international aspect of the business (beyond the international scope of the markets) interesting. — **Arthur J. Carp**, Secretary, Sandro Rohstoff, Inc., 1 World Trade Center, Suite 9853, New York, NY 10048

77

Randy Perez writes that he is in the third year of graduate study in organic chemistry at the University of Michigan. . . . **Andrew Werber** is presently in the Ph.D. program at Michigan State University in pharmacology and toxicology. He was married last August to Janice Goodman of Lansing, Mich. . . . **Darwin Fleischaker** writes "After receiving my S.M. from M.I.T. in 1978, I entered New York University Medical School. Last summer as a member of a health team, I worked in the surgical ward of the Royal Victoria Hospital in Banjul, The Gambia, West Africa. I also took part in immunization and health education programs in remote jungle villages (lots of infectious and tropical diseases but no hypertension or obesity!). Learned Mandika and Waloof (local languages), toured Senegal and came within 80 kilometers of Timbuktu in Mali. The Africans are a beautiful people. It was quite a change being in a place where friendship and hospitality are paramount and where time does not exist."

Matt Sherman just completed his M.D. at Dartmouth Medical School and is now a resident in internal medicine at Georgetown University hospital in Washington, D.C.

Out on the West Coast, **Biff Brisbin** received his M.B.A. from Stanford in June of 1979, and is working as an engineer for Bechtel in San Francisco. . . . **Mark Green**, also in the Bay area, writes, "I continue to work as a telecommunications software/networking consultant for the San Francisco Consulting Group. Have recently founded an integrated systems group in Berkeley to develop advanced microcomputer systems. Living and working in the Bay area is great! . . . **Sam Gasster** is working on his Ph.D. in physics at U.C. Berkeley, with C. H. Townes in the quantum electronics/astrophysics group. . . . The last I heard, **George Hayes** was also in San Francisco working as an assistant vicepresident for E. F. Hutton and Co., Inc., in the corporate finance group.

Debbie Stutman writes, "Received M.S. in astronomy from Penn State in August, 1977. Presently, I am back in chemical engineering, now at Lehigh University, working on emulsion polymers." . . . **James Eiser** has finished his last year at N.Y.U. law school and is working as an associate in the New York law firm of Curtis Mallet-Prevost, Colt and Mosle, specializing in international law. . . . Also finishing up law shcool is **Bill Brown** who has just completed his stay at Duke and says: "I'll be staying here in Durham over the summer to take a review course for the New York bar exam, which I will take at the end of July. After that and a vacation, I will start work for a large law firm in New York City." . . . Here's a note a few months out of date (my fault, not his) from **Paul Ackman**: "After two years in the physics department at U.C., San Diego, I got fed up and quit. Hooray! **Karen Kaufman**, my old 8.13 partner, and Gabe Bramson, '78 also left the U.C.S.D. physics department this summer. (Hint: this was no mere coincidence) Karen is at General Dynamics at San Diego, and Gabe is at General Atomic in LaJolla. I'm a 'lab associate' (physics peon) at the Aerospace Corp. in El Segunda (you've seen their ads). It's a good place. I'm in laser physics now. No one wanted to hire an astrophysicist. If you're in the neighborhood or need to be talked out of studying physics at U.C.S.D., give me a call."

David Batchelor just finished his third year at grad school, University of North Carolina and should get his Ph.D. in physics about 1982. He's enjoying teaching astronomy labs and working on a thesis in general relativity in astrophysics. . . . **Bon Foster** is now an assistant director of aeronautics for the State of Illinois, "adrift in a sea of corn and soy, I long for those city lights." . . . After graduation from Queens University in Kingston, Ont., with an M.A. in economics in May, 1979, **Rob Miller** traveled to Israel for the summer and has been working at the energy strategy branch of the Federal Department of Energy, Mines and Resources in Ottawa. . . . **Rich Buck** is finishing up an assignment for a Kendall Square consulting firm that has him living in Fort Wayne, Ind., on a project for Lincoln National Life Insurance. He has been doing programming and analysis in conjunction with their daily cycle for individual life insurance. "I haven't had the opportunity to play soccer out here, but I'm looking foward to finding a team when I return to the Boston area."

Mark Allan Long is another one of our class business consultants. He is working with Arthur Andersen and Co. in Cleveland. . . . **Rich Smiley** has just finished his third year at Columbia University, working toward his Ph.D. in bioorganic chemistry involving the (attempted) synthesis of artifical enzymes. He has been sharing an apartment with **Mike DiNovi**, who is also in the Columbia chemistry Ph.D. program. . . . **Mark Vincent** has opened a Computerland retail microcomputer store in the Pittsburgh area. He is no longer with Corning Glass Works. . . . **Bill Greisser** is now working for Texas Instruments in Louisville, Tex. . . . Also down that way is **Steve Grossman**, who after finally finishing his thesis in the summer of 1977, went to the University of Pennsylvania to pursue an M.B.A. at the Wharton School. "While at Phildelphia I worked as director of marketing at a small computer software firm, International Database Systems, Inc. I moved to Dallas, Tex. in July, 1979, to work for Mostek Corp. as a product line manager with responsibility for the smooth introduction of new memory components. It's fun, and I'm enjoying the Sun Belt. . . . **Kenny Sun** was married to Shirley Cartharius in September, 1979; I assume he is still up in the Pacific Northwest. That's it for now. Any and all news is welcome. — **Douglas J. McLeod**, Secretary, 1541 Smith St., Green Bay WI, 54302

78

Naomi Johnson recently packed up her bags and her recent fiance (Dave Miller, '79) and left Detroit for Palo Alto, Calif. Naomi is working as a lighting engineer in a very progressive electrical engineering consulting firm in San Jose while Dave attends grad school at Stanford. The wedding will be in Detroit in September.

Arnold Chu writes that he is presently doing "CAD" work at Bell Labs, Whippany, N.J. . . . **Rich Brudnick** got his master's from Sloan this past December and is now working as a consultant with Bain and Co. in Boston.

Diane Curtis and **Eric Ziering** were married shortly after graduation. Both stayed on at the 'tute for their master's (in management and transportation, respectively), and they are now working in the Boston area. Diane is working on a personnel information system for Polaroid in Waltham, while Eric is doing transportation systems consulting for Charles River Associates in Boston. . . . **Kevin Mann** writes that he has beem working on land use planning for the Hopi Tribe; his work concerns over 900,000 acres within the Hopi Reservation.

Bill Dershowitz writes that he is now: 1) Married to Susan Hankin as of July, 1979, 2) Employed at Golden Associates, Inc., a geotechnical engineering mining consulting company, and 3) Enjoying the beautiful northwest (but then, that was written before Mt. St. Helen became a household word).

Jerrold Liebermann will be traveling across the country during his summer vacation from Stony Brook Medical School. . . . **Carolyn Morrow** writes from California that she is working for the U.S. Geological Survey out there. Also out in California is my friend **Jean Gregory** at Stanford. Jean writes that she is "still plugging away on the Ph.D.; I passed the qualifying orals last fall." From a Baker House contingent, **Sue Ann Hanson** writes from the suburbs of D.C. that she has "joined the middle class" by purchasing a townhouse (only a half mile from Dave Passmore '77). Sue, who went to work at a D.C. civil engineering consulting firm after getting her master's at Berkeley, will be a lecturer at the University of Virginia part time, giving a seminar for civil engineering grad students.

The grapevine has it that Sue's old roommate, **Karyn Altman** has decided to give up engineering and start a *real* career. Karyn is going back to school to get her master's in physical education with the aim of becoming a volleyball coach. . . . **John Richardson** was married to Hillary Lust in February. They're living in Chicago for now, but in August they'll move to New York City where Hillary will be at Cornell Medical School and John will probably be working for Bell Labs in New Jersey.

John's old roomate, **Rick Losk**, is half finished with his M.B.A. at the University of Chicago, going to school at nights. During the day he works full time at Helene Curtis Industries, developing decision support/management information systems. Rick recently announced his engagement to Mona Abt, who also works in Chicago; the date is set for late this August.

Would-Be-Olympic-Jocks: our class has two of them. **Mark Smith** (recent amateur youth national champion in fencing) traveled in Germany and Italy to train in foil fencing, while competing throughout Europe. Mark hopes to make the national team. . . . **Alan Marcum**, California State Air Rifle Champion, will shoot in the National Championship in Phoenix, also hoping to make the national team. He too has been traveling in Europe, but not to train; he gave a paper at the "APL" conference in Holland. Al reports running into **Geoff Baskir** in Palo Alto and **Jim Heeger**, who stopped out to visit Stanford, where he will begin business school this fall.

Cute couples: **Sam** and **Carol (Brown) Senne** were married the night before graduation, and shortly thereafter disappeared into the wilds of Florida. (Since Carol is on the class executive committee we've been looking for her.) Both have been working for United Technologies at Kennedy Space Center on the shuttle program (concentrating on the design and manufacture of the solid rocket boosters). Their big news, however, is Christine Senne (8½ lbs.) born this Janurary 3. To my knowledge Christine is the first baby born to two of our classmates. Congratulations.

George (Skip) and **Debra (Abott) Page** were married a year ago. They are now living outside of San Francisco — Debbie is working for an architectural firm and Skip for Chevron Chemical Co. as a chemical engineer.

More Californians: **Brad Albom** writes from the Bay Area, "For close to two years I've been working for Chevron Research Co. Everything is going well at work and in my spare time I've been wheeling and dealing in real estate." . . . **Rich Perlstein** took a year off from Berkeley to work as an architectural designer in Cambridge. "It took a month of ringing doorbells to find it, but then they never promised us that it was an easy field." Rich will return west this fall to finish his M.Arch.

Josie Stein writes from Pasadena that she's working in the thermal design group at the Jet Propulsion Lab (JPL) "specifically on an advanced concept for a radiative cryogenic cooler for long-term space flight." ("Open the pod bay doors, HAL!") She reports that there are two M.I.T.'ers in her group (Bob Hughes and Stu Glazer, both grad students who graduated with us). Josie's old roommate at Berkeley, **Jerry Epstein**, reports that he's still pursuing his astrophysics doctorate there.

Bill McGrath writes that he is "currently engaged in running a successful hang-glider business (lessons, sales, and rentals). Hope to get into the scuba market and deepsea fishing." . . . **Bob Wolf** writes from Edwards Air Force Base near L.A. Bob got his master's in aero from Stanford last year, "almost by mail" and since then has been a flight engineer for the air force. Bob reports that during his year at Stanford he often ran into **Dave Medeiros**, who he says has returned to the Boston area and is now designing nuclear power plants.

Also in California are **Regina Murphy** (working for Chevron in Richmond), **Leonard Napolitano** (working at Sandia National Labs in Livermore and going for his doctorate at Stanford) and **Herbert Lindsay** (master's in hand, will continue for his Ph.D. at UCLA).

Thanks to **Jim Bidigare** and **Milton Roye**, who ran a telethon for the Alumni Association just for the purpose of gathering gossip for this column.

Meanwhile, back at the 'tute: **Reid Von Borstel** writes that he is one year into graduate work at M.I.T.'s Department of Nutrition and Food

Science, after recieving a fellowship from the National Science Foundation in February, 1979. He still high jumps on occasion, retaining the indoor record last December. . . . **Ricky Ewasko** will be heading back to M.I.T. for a master's in materials science, after working for the past year at Westinghouse.

Joseph Paige finished his master's from the 'tute this spring and, last I heard, was hoping to settle in his home-town, Washington, D.C. . . . **Siu Lam** also finished his master's from M.I.T. and started working at Lexicon in Waltham. . . . **David Cope** is in a Ph.D. program in physics while working as an engineer at Avco Corp. **Juan Pineda** is also in the graduate physics department.

My old roommate, **Bob McLay** is going for a Ph.D. in electrical engineering-computer science. . . . **Jim Harrison** reports that he just got his master's from course VI and will soon be facing the real world. . . . **Franklin (G-T) Ching** is in the civil engineering department going for his M.I.T. Ph.D.

Rita Russell has stayed on to work at M.I.T. at the Office of Facilities Management, doing documentation and analysis of different uses of space in the Institute buildings. . . . **Larry Siegel** is in the Joint M.I.T.-Harvard program in health sciences and technology. . . . **Jim Cherry** is doing integrated-circuit research in the artificial intelligence labs in Tech Square. . . . Super juggler **Artie Lewbel** will be bringing his unicycle and indian clubs back to the Institute in the fall, but this time wearing a suit. Artie will be starting at the Sloan School in the fall, after a brief respite at Data Resources, Inc.

Our classmates in uniform: Ensign **Catherine H. Osman** became one of 16 women selected by the Navy to begin training for her "wings." When she gets there she may run into another classmate, Ensign **Drahomir Lazar**, who is training for his wings at the Pensacola, Fla., Naval Air Station, aiming to be a radar intercept officer.

Kathy Keilmeyer seems to be wearing two hats. While working at Fairchild Space and Electronics Co. in Germantown, Md., as an associate engineer, she is also the assistant adjutant of the 11th Special Forces Group (Airborne) at Ft. Meade. . . . Also, **John Anderson** is stationed in Germany with the Army.

Our classmates in white coats: **Lloyd Benjamin**, who will be starting in the wards in Houston this fall, writes that he made his first pilgrimage back to the great domes of Cambridge this summer, "engaging heavily in sinful acts for two weeks. I presume that it was delightful." . . . Probably better treated will be the patients of **Tuan Nguyen-Duy**, who finished his second year at Albert Einstein College of Medicine in N.Y.C., and started in the wards last March. . . . In St. Louis **Dave Karp** is working on his M.D. and Ph.D. at Washington University. . . . **Bob Lafyatis** says he loves the University of Cincinnati's Medical School. . . . **Carl Krasniak** is in Rochester after he returns from a summer of doing research. . . . At Columbia in New York, **John Dillon** will return for his third year after a summer at Dynatech in beautiful Cambridgeport. . . . **Ray Dugal** will be moving on to his third year at the University of Massachusetts Medical School.

Also spending a lot of time in white coats these days will be **Diane Prignoli** who is working in New York "coaxing white blood corpuscles of various antigenic persuasions into telling us mere mortal scientists how they all coexist and coordinate and get things done." . . . Also there's **Brent Cochran** who'll be wearing his white coat at Harvard's Biology Graduate School. . . . **Jenny McFarland**'s will also be at Harvard after doing research at Boston University's Medical School.

Our classmates in three-piece suits: **Kathy Lyon** will be starting at Harvard Business School this fall (after working at Cambridge Collaborative) along with **Steve Claflin** and **Greg Holzwarth**. . . . **Jeff Felton** is finishing up at Chicago Business School and will be working with a systems consultant firm in Cambridge. . . . **John Dell'Aquilla** will be wearing two three-piece suits at once — he's working on both an M.B.A. and law degree at Wharton (University of Pennsylvania). . . . **Gary Kurzban** writes that he "is still with F. W. House of Houston supervising the terminal stages of the development and marketing of a series of innovative anti-roach products known as the 'Siegfried Line'."

R2D2 here welcome — **Michael Saylor** is working on R2's great grandfather; Michael just joined Automatics, Inc. which deals in industrial robotics. . . . **Peter Weyman** writes that he has left Electronics Corp. of America to become manager of software engineering at Identicon Corp., in Franklin, Mass., which deals in optics, such as label readers. . . . **Willard Marquis** is working as a design engineer for Hewlett Packard in Waltham.

Alice Cowan, due to a foul-up, appeared twice in one column (two issues ago). "The previous info is now obsolete; I just started a new job at General Mills, (Minneapolis), and I'm now working on the phytofarm project, or continuous hydroponic production of salad greens."

And as for your Secretary, I'm spending the summer in Ann Arbor living with my girlfriend and working as a research assistant for a professor at the law school. — **David Browne**, Secretary, 315 N. Thayer St. #7, Ann Arbor, MI 48104

79

Greetings, fellow class members! M.I.T. has sent another graduating class into the world, making us recent graduates feel very old!

Got a wonderfully friendly postcard from **Karen Chang**. Karen had the pleasure of fulfilling the role of bridesmaid at the May wedding of **Vicki Chang** and David Chang, a young man whose associations lie with that liberal arts school up the Charles River! (Believe it or not, none of the aforementioned Changs are related!) Other wedding attendants included Cindy Chen, '78, and Clifton Chang, '71, who is actually Vicki's brother! Clearly someone who thinks big, Vicki had her ceremony at Trinity Church in Copley Square and the reception at the Great Hall in Faneuil Hall Marketplace. Vicki has been working in Quincy Market all year for Bain and Co., a management consulting firm, and plans to attend Stanford Business School in the fall. I'm sure the class of '79 joins me in wishing Vicki and David the best of luck.

As for Karen, she is studying respiratory physiology at the Harvard School of Public Health. **Peiti Tung**, who has been sharing an apartment with Karen, Vicki, and Jeannette Wing, '78, finished her S.M. in January.

Speaking of weddings, **Susan Reed** reports that she has been happily married since last September and is now Mrs. Robert Wooster! Susan has just finished her first year as a management trainee at New England Telephone Co., where she occasionally bumps into other M.I.T. grads. . . . **Charles Bright**, an assistant sales engineer for Westinghouse down in Dallas, reports, "I will be soon on my feet all day as an engineer for Power Generation Service, the division that fixes steam and gas turbines in situ over the northern half of Texas. Definitely will hit the beach this summer!" . . . **Jim Thompson** is married and living in Pittsburgh as a master of architecture student at Carnegie-Mellon University. Jim, a brother of Theta Chi, was awarded M.I.T.'s Colley Trophy in recognition of his "service and leadership to Alma Mater, Chapter, and Fraternity." Congrats! . . . Also at Carnegie-Mellon are **Douglas Morrow** and **Howard Pien**, both first-year students in the master's program at the Graduate School of Industrial Administration (that's just a fancy name for business school!).

Out in California . . . **Cecelia Webster** is working in the Pharmacology Department at Stanford Medical School — "loving California, planning on graduate school in 1981 or 1982, and learning to fly!" . . . **Richelieu Hemphill**, on a National Science Foundation Fellowship at Berkeley, announced plans last spring to "return east if it ever stops snowing!"

Peter Steinhagen reports that "Dr. Wiesner gave a well-received talk at 3M's Universe Room on April 8. Our chemical engineering group was impressed with his talk: 'What the Industrial Scientist should know about University Research'." . . . **Margot Tsakonas** writes, "After finally finishing my thesis in August, 1979, I graduated and was commissioned a lieutenant in the army (Corps of Engineers). I'm stationed at Ft. Belvoir, Va. From September to December I attended the Engineer Officer Basic Course, a 14-week school on military and combat engineering. I am currently executive officer for the company that administers the course. I'm 25 minutes from downtown D.C. — the area is fantastic. I'm also shooting for the Ft. Belvoir Rifle Team. In all, I'm enjoying this life very much."

That's all for this month. Please send more dirt — the mail is trickling in, and I want to hear from every last one of you (that means you!) — **Sharon Lowenheim**, 3600 Chestnut St., Box 1166, Philadelphia, PA 19104

80

Greetings, all, and welcome to the first of many, many columns tracking the adventures and misadventures of members of our class.

Before Commencement, I had the pleasure of attending the wedding of Michael Stiefel, '75, where I ran into M.I.T. students spanning quite a number of years, including several from our class. **Joe Gerhardt** is currently an EECS co-op student working for I.B.M. in Yorktown Heights, N.Y. He will be returning to M.I.T. in the spring to complete work for a master's degree. . . . Also working on his master's at M.I.T. is **Geoff Cooper**, who will be doing his studying in computer science. . . . **Miriam Nadel** will be heading out to sunny California to do graduate work in mechanical engineering at U.C. Berkeley. . . . **Ron Wides** will be in California doing Ph.D. work in biochemistry at UCLA this fall. . . . Also heading out to UCLA to do Ph.D. work are **Amy Hendel** and **Wayne Lewis** — Amy in math, and Wayne in physics. Amy and Wayne, incidentally, were married on June 8. Congratulations to both of you!

As if UCLA was not already getting enough of our classmates, **Sherman Elspas** will also be there, starting the long trek toward becoming a physician. Sherman will be back in his home state; just prior to leaving M.I.T. this spring, I caught him dusting off his surfboard!

It may seem as though all of our colleagues are continuing toward some higher form of education. Not so. After taking a month off to travel and relax, **Evan Shapiro** jumped right into the real world, doing some computer work for Honeywell, Inc., in Billerica, Mass. . . . **Dean Phillips**, just before leaving Cambridge, informed me that he had plans to head down to Connecticut to help his brother campaign for a state office.

Back in the academic world, there seems to be many people in our class participating in the EECS co-op program. **Rich Chin**, who has been working at Hewlett-Packard Co. since January, returns this fall to M.I.T. to finish up the final leg of his master's and bachelor's degrees in electrical engineering. . . . **Mickey Lee**, **Louis Nagode**, **Mark Plotnick**, and **Joe Pasquale** are all doing co-op work with Bell Laboratories in New Jersey until January. Reportedly, Joe is trying to make some "beautiful music" down there. Knowing Joe, that can mean any number of things. . . . **Kevin Wallace**, staying on campus for the summer, is working on his co-op with Digital Systems Corp. in Maynard.

Chris Cholaj is at M.I.T. studying electrical engineering under a Hughes scholarship. He spent the summer with Hughes Aircraft Co. in L.A. They promised to reciprocate and come to Cambridge to spend next summer here with him. . . . Also doing graduate work in electrical engineering at M.I.T. is **Finley Shapiro**, working under a National Science Foundation graduate fellowship.

So ends the first column and my vast knowledge of my friends' and neighbor's activities. Unfortunately, though, this cleans me fresh out of gossip. I'll be counting on all of you to supply it to me from here on. If you don't feel like telling me what you are doing, tell me what someone else is doing. If that doesn't tickle your fancy either, make something up about someone else (so that I don't have to). Letters, cards, and packages of food can all be sent to — **Ken Turkewitz**, Secretary, 241 Lexington St., Bldg 15, Apt.2D, Woburn, MA 01801

Dr. Killian Given the Bush Award

Early this year the National Science Board, governing body of the National Science Foundation, honored the memory of **Vannevar Bush**, '16, former vice president and dean of engineering at M.I.T., by attaching his name to a major new award for "senior statesmen of science and technology"; Dr. Bush was the architect of the government's pioneering role in supporting basic research and education in the sciences at the end of World War II. Then on May 15 the NSB made the first Bush Award to one of Dr. Bush's proteges — **James R. Killian, Jr.**, '26, the first White House science advisor who was president of M.I.T. from 1949 to 1959. (At the same ceremony, Roy F. Schwitters, '66, now professor of physics at Harvard, received the NSB's prestigious Alan T. Waterman Award — a grant of up to $50,000 a year for three years for study and research.)

Three New Members of The National Selection Committee

The three newly elected members of the National Selection Committee are: Edward D. Kane, '47, from District Three; John J. Casey, '40, from District Eight; and H. Dubose Montgomery, '71, from District Nine.

Edward Kane is the director, planning and business development power systems group, at Combustion Engineering, Inc. He lives in Windsor, Conn.

John Casey, from Carrollton, Tex., is group vice president and vice chairman of the board of Braniff International.

H. Dubose Montgomery is managing director of Menlo Financial Corp., and lives in Hillsborough, Calif.

The committee's task is to select national officers — president, vice presidents, and directors — of the Alumni Association for 1981-1982; its deliberations will begin late in the fall, and comments and suggestions should be sent in the meantime to Richard A. Knight, secretary of the Association, at Room 10-110, M.I.T.

Corporation Changes

Six faces new to the M.I.T. Corporation will be among those present when it meets in September to inaugurate Paul E. Gray, '54, as the Institute's 14th president:

☐ **Harl P. Aldrich**, '47, co-founder of and president of Haley and Aldrich, Inc., consulting geotechnical engineers and geologists of Cambridge, Mass.

☐ **Colby H. Chandler**, S.M.'63, president of Eastman Kodak Co.

☐ **Kenneth J. Germeshausen**, '31, co-founder and former president, chairman, and director of research of Edgerton, Germeshausen and Grier, Inc. (E G & G, Inc.) of Bedford, Mass.

☐ **John S. Reed**, '61, senior executive vice president of Citicorp and Citibank.

☐ **John Riboud**, chairman of the board and chief executive officer of Schlumberger, Ltd., New York City.

☐ **David R. Wilson**, '73, who received his Ph.D. in mechanical engineering from M.I.T. on June 2.

Messrs. Chandler, Germeshausen, Reed, and Riboud hold five-year terms on the Corporation, the result of elections held at its meeting on June 2. Dr. Aldrich joins the Corporation ex-officio as president (1980-81) of the M.I.T. Alumni Association, and Dr. Wilson was elected to a five-year term by alumni of recent graduating classes during the spring.

The status of eight other members of the Corporation was effected by elections which took place at the Corporation's meeting on June 2. **Jerome B. Wiesner**, who has been a member of the Corporation as president of M.I.T. since 1971, was named to life membership. Four members of the Corporation were re-elected to five-year terms: **Shirley A. Jackson**, '68, a member of the Technical Staff at Bell Laboratories, Inc.; **Norman B. Leventhal**, '38, president of the Beacon Cos., Boston; **Harold J. Muckley**, '39, former president of the Houston (Tex.) Contracting Co.; and **William J. Weisz**, '48, vice chairman and chief operating officer of Motorola, Inc.

Claude W. Brenner, '47, completed his one-year ex-officio membership on the Corporation as president of the Alumni Association and was elected to a five-year Corporation membership.

H.P. Aldrich

C.H. Chandler

K.J. Germeshausen

J.S. Reed

J. Riboud

D.R. Wilson

William J. Hecht, '61, who became well known to many alumni as executive secretary and director of the Educational Council from 1967 to 1976, has returned to the Institute as executive vice president of the Alumni Association.

Alumni Management Post to William Hecht

William J. Hecht, '61, who served as executive secretary and later director of the Educational Council from 1967 to 1976, returned to M.I.T. on August 1 to become executive vice president of the Alumni Association and publisher of *Technology Review*, succeeding James A. Hester, Jr., '65.

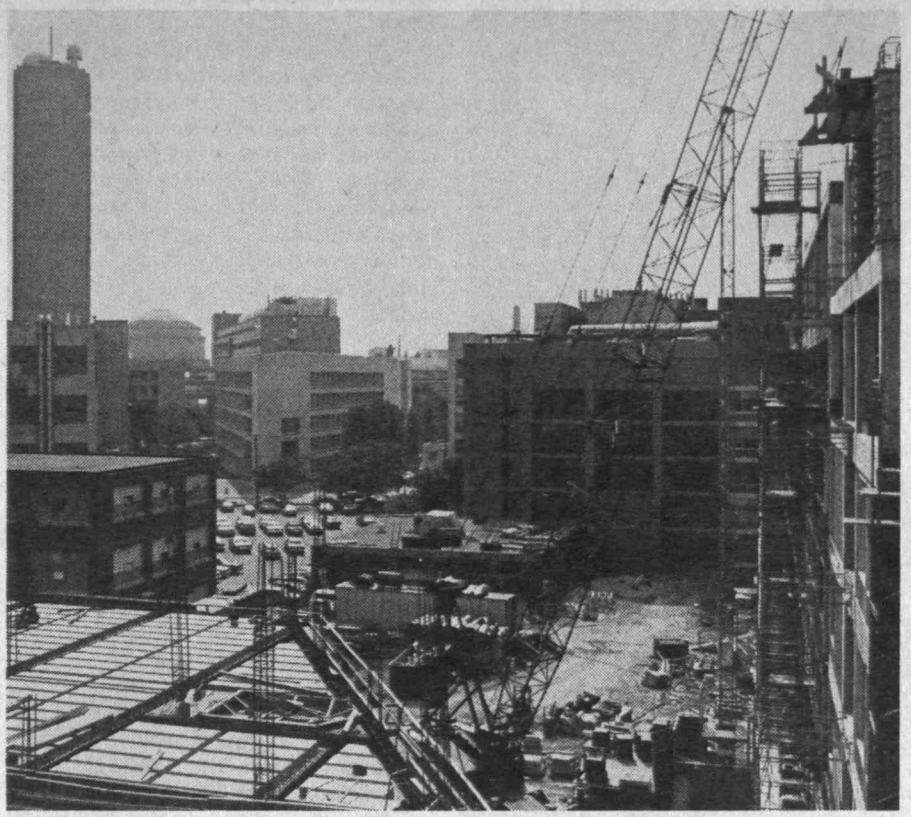
The announcement from Claude W. Brenner, '47 — one of his last official acts as president of the Alumni Association for 1979-80 — and Paul E. Gray, '54, president of the Institute, called attention to Mr. Hecht's "knowledge of alumni affairs and his personal acquaintance with many alumni and alumnae.

"We join in wishing him success in this critically important post," they said.

Mr. Hecht was unanimously recommended for the post by a search committee of which Mr. Brenner was chairman; other members included Harl P. Aldrich, Jr. '47, the 1980-81 president of the Alumni Association; Thomas H. Farquhar, '60; Sylvester J. Gates, '73; Breene M. Kerr, '51; Norman B. Leventhal, '38; Philip H. Peters, '37, and Emily L. Wick, '51. The action of the Alumni Association's Board of Directors in appointing Mr. Hecht was also unanimous.

Mr. Hecht holds both bachelor's and master's degrees in management from M.I.T. He began his career with the New York Telephone Co. following graduation from the Institute. During 1975-76, on leave from the Educational Council, he was a Sloan Fellow, receiving the S.M. degree in management at the end of that year, when he joined Waters Associates, Milford, Mass., as manager of human resources and later plant manager.

Dr. Hester, whose resignation was effective July 1, has returned to the field of health care management in which he was active before coming to M.I.T. in January, 1979; he



The single largest building project at M.I.T. since 1916 is growing apace on the East Campus – the new complex for the Whitaker College of Health Sciences, Technology, and Management and the M.I.T. Medical Department. A six-story atrium, still to take form at the center of this picture, will connect two buildings serving the Whitaker College (right) and the Medical Department (left) while at the same time forming a visual link between the East Campus and the main "spine" of M.I.T. The two buildings and the central atrium will provide a total of 223,000 square feet of floor space; the cost is set at $29 million, and occupancy is planned for September, 1981. (Photo: D. J. Dudzik)

is now an associate director at New England Medical Center Hospital, Boston.

The Provost's Office Takes Professors Perkins and Smith

Francis E. Low, Karl Taylor Compton Professor of Physics who is now serving as provost in the administration of President Paul E. Gray, '54, has completed organization of the Provost's Office by naming two members of the School of Engineering faculty as associate provosts — **Frank E. Perkins**, '55, formerly head of the Department of Civil Engineering, and **Kenneth A. Smith**, '58, Joseph R. Mares Professor of Chemical Engineering.

Louis Menand III, senior lecturer in the Department of Political Science, will continue as special assistant to the provost and Charles M. Placido, administrative assistant, will become administrative officer.

Hartley Rogers, Jr., professor of mathematics who has been associate provost since 1972, will return to teaching and research and will be on leave at Harvard University during the coming year. Professor Low expressed regret at his departure from the office, saying that Professor Rogers had served "with distinction."

Haystack Director

John V. Evans, who obtained his Ph.D. while using Britain's famous Jodrell Bank radio astronomy station, is now director of the Haystack Radio Observatory and professor in the M.I.T. Department of Meterology; he will also continue as assistant director of Lincoln Laboratory.

As director of Haystack, Dr. Evans succeeds Paul B. Sebring, who is retiring. Mr. Sebring was Haystack's first director, and he was recently honored by its board for his "leadership in (bringing) the observatory to its present position at the forefront of radioastronomical research." Haystack is operated by M.I.T. on behalf of the Northeast Radio Observatory Corp., a consortium of 13 New England universities; it was built and first operated by Lincoln Laboratory in the 1960s.

Dr. Evans was born and educated in Manchester, England; he came to the U.S. to join the Lincoln Laboratory staff in 1960.

Robert J. Radocchia, 1915-1980

Robert J. Radocchia, who was manager of Walker Memorial from 1964 until his retirement in 1977, suffered a fatal heart attack during the annual dinner for retiring members of the Institute staff and faculty on June 3 in Walker Memorial; he was 65.

Mr. Radocchia came to M.I.T. as a cook in Walker Memorial in 1939 and by 1941, after one year in the Purchasing Office, was head steward and party manager at Walker. Following his retirement he served part-time as manager of the M.I.T. Quarter Century Club and president of the M.I.T.-Cambridge chapter of the American Association of Retired Persons, and it was in these roles especially that he had done much to foster a sense of community at the Institute.

A Roman pigeon posing for "Papa Flash."
In Rome to give a five-day course in high-speed photography, Professor Harold E. Edgerton, Sc.D. '31, took his search for subjects to the street. Two students, appointed the "pigeon searching committee" for the 18 members of the class, spent an early-morning hour in St. Marco Square with a bed sheet and some corn as bait. Back in the studio, black strings were used to restrain the birds and voila.

Marvin E. Goody, 1929-1980

Marvin E. Goody, M.Arch.'51, co-founder and senior partner of the architectural firm of Goody and Clancy (now Goody, Clancy, and Associates), died after a heart attack on May 18 while sailing off New Bedford with his architect wife, Joan Edelman Goody, a partner in the firm. Considered among Boston's leading architects, he was 51.

Mr. Goody taught architecture at M.I.T. from 1956 to 1966, when he resigned to devote full time to his architectural practice. In addition to his M.I.T. degree, he held a bachelor's degree from the University of Pennsylvania (1950) and a master's degree in city planning from Yale (1952). He was the designer of an award-winning housing complex for the elderly in Stockbridge and of a new State Transportation Building now under construction in Park Square, Boston.

Daniel Lerner, 1918-1980

Daniel Lerner,, who was on an extended leave from his post as Ford Professor of Sociology and International Communications in the Department of Political Science, died in Santa Cruz, Calif., of bone cancer on May 1; he was 62.

Professor Lerner came to M.I.T. in 1953 to join the Center for International Studies; already he was well known in the field of political analysis as research director of an international studies project at the Hoover Institution and Stanford University. Since coming to the Institute, Professor Lerner had helped found the Institut d'Etudes Europeennes in Paris, where he was research director from 1954 to 1965; during many of the same years he also directed a colloquium on scientific concept and method at the Institute. In all, he had published more than 20 books, the most important of them being *The Passing of Traditional Society: Modernizing the Middle East* (1958).

Robert A. Smith, 1909-1980

Robert A. Smith, a native of Scotland who was professor of physics and director of the Center for Materials Science and Engineering from 1962 to 1968, died of a heart attack in Edinburgh, Scotland, on May 16, his 71st birthday.

Professor Smith, known at M.I.T. as "Robin," came to the U.S. from the Royal Radar Establishment in Malvern, England, where he was head of the physics department, in 1961. M.I.T. colleagues remember him as "a brilliantly gifted administrator who helped create an outstandingly strong, integrated activity in materials science, . . . a man who could blend together people of entirely different disciplines into a great sense of camaraderie and shared objectives."

Professor Smith had returned to England in 1968 to become vice chancellor (president) of Heriot-Watt University, Edinburgh — a post in which he served until retirement in 1974.

William H. MacCallum, 1901-1980

William H. MacCallum, '24, who had been a member of the Executive Committee of the Alumni Association in 1967, 1968, and 1969 and was active in many alumni clubs and activities, died in Cotuit, Mass., on June 12. His death, which occurred with that of his wife Eleanore MacCallum in a car parked in the driveway of their home, was ruled a suicide; both were 79.

Mr. MacCallum entered the photographic supply business in Philadelphia in the 1930s, and by 1937 he had turned to motion picture distribution as executive vice president of Modern Talking Picture Service in New York; he was for many years executive vice president of the American Science Film Association.

Courses

A red letter day for Captain Peter G. Beierl (U.S.N. Ret.), N.E.'51: on June 1 on the deck of the U.S.S. John F. Kennedy he had the privilege of swearing in two new Navy ensigns, his son Philip C. Beierl, '80, and his daughter-in-law-to-be, Dorothy S. Russell, '80. Ensigns Beierl and Russell received their M.I.T. degrees (he in naval architecture, she in biology) on June 2, were married in Kittery, Maine, on June 3, and shortly thereafter went to their first duty assignment at the Navy's Surface Warfare Officer School in Newport, R.I. (Photo: Calvin Campbell)

I
Civil Engineering

Frank E. Perkins, Sc.D.'55, has recently been appointed associate provost of M.I.T., and a search is being mounted for his successor as head of the department. . . . **William Merkel,** S.M.'75, is currently working for the U.S. Soil Conservation Service as a hydraulic engineer, Sacramento, Calif. . . . **Wayne Huber,** Ph.D.'69, is presently professor of environmental engineering sciences at the University of Florida, Gainesville. . . . **E. Lile Murphree, Jr.,** S.M.'58, reports; "I received a Ph.D. in civil engineering systems from the University of Illinois, Champaign-Urbana, in 1967; spent several years on the faculty at U.I.U.C; six years as a division chief at the U.S. Army Construction Engineering Research Laboratory and am presently consultant and president of Sage Systems Corp., Urbana, Il.

Wilbur L. Hankey, Jr., S.M.'53, has won the 1980 General Foulois Award presented by the Flight Dynamics Laboratory of the Air Force Wright Aeronautical Laboratories, for his accomplishments in the field of aerodynamics. . . . **Martin L. Johnson,** S.M.'59, has been appointed vice-president of DuBois and King, Inc., responsible for many facets of enviromental maintenance, Randolph, Vt.

Wilbur L. Hankey, Jr.

II
Mechanical Engineering

Milton C. Shaw, former professor in the department and head of the materials processing division (1946-1961), has been given a 1980 international honor award by the Society of Manufacturing Engineers for his "... enlightment about industry to this society, but, more importantly, to his students, who are destined to serve us in the next generation of engineers."

R. Leon Leonard, S.M.'63, has been named department head at Radian Corp., Austin, Tex. . . . **Avi Swartzon,** S.M.'75, is presently a senior engineer in Eastern Airlines' Engineering and Reliability Projects, developing and analyzing maintenance programs and standards. . . . **Max Donath,** Ph.D.'78, writes, "I received the Military Order of the Purple Heart Award for outstanding research in services to the handicapped at the president's annual Conference for Employment of the Handicapped in Washington, D.C., on May 1, 1980, and am presently assistant professor of mechanical engineering at the University of Minnesota.

Notice has been just received of the death of **Bal D. Kalelkar,** S.M.'41, on May 26, 1974. . . . **Marcel R. Harper,** S.M.'64, reports that he is currently a member of the technical staff at the Aerospace Corp., involved in study of energy storage in solar energy applications. . . . **John C. Chato,** Ph.D.'60, writes, "I was invited to give a keynote address at the second annual International Conference on Mechanics in Medicine and Biology at Osaka, Japan, this past June. Last year I was a Fogarty Senior International Fellow at the Bioengineering Institute, Zurich, and also received the Russell B. Scott Memorial Award for the outstanding research paper presented at the Cryogenic Engineering Conference.

III
Materials Science and Engineering

Rodney Hanneman, Ph.D.'61, reports that he has been appointed manager, materials programs and evaluation operation at the General Electric

Research and Development Center in April 1980. He was a recipient of the Edison Medallion last year for contributions to lucalox lamp technology and has previously held several management positions in research and development at General Electric. . . . **Michael Humenik, Jr.,** Sc.D.'52, has been awarded honorary membership in the Society of Manufacturing Engineers for his contributions toward increased industrial efficiency through his development of titanium carbide as a cutting tool material.

IV
Architecture

Professor Julian Beinart has been elected president of the International Design Conference in Aspen, Colo., a major world forum for exploring ideas about the designed environment. . . . **Adrienne A. Brecher,** M.Arch.'74, writes, "I now have my own firm, specializing in real estate marketing and movies. (Who would have thought I would make a movie!) Presently, one office building is under renovation and two more are planned by June, 1981, and I am producing a merchandising real estate newsletter out of Chicago. . . . **E.A. Glendening,** M.Arch.'54, has been elected to the College of Fellows of the American Institute of Architects for his significant design accomplishments.

Marvin Goody, M.Arch.'51, died on May 18, 1980. He was a prominent Boston architect whose designs included the future state transportation building in Park Square, the award-winning housing complex for the elderly in Stockbridge, an addition at Simmons College, and the Seeley G. Mudd Cancer Research Center at M.I.T. He was also a research associate and professor in the department (1953-1968).

Masaski Sakurai, S.M.'60, is now in charge of a unique academic curriculum in Japan: structural engineering for marine architecture, environmental engineering, and survey and design for coastal and shallow-sea-area zone management.

When Edwin S. Rich, S.M.'48, retired from his job at Mitre Corp., Bedford, Mass., last March, he and Ruth were showered with good wishes. Then they pulled up stakes and moved to Woolwich, Maine, just across the river from Bath. "Retiring feels great," Mr. Rich said; he's had lots of hobbies – "all kinds of things" – and there would be gardening, woodworking, and furniture making. "You realize you're going to miss everybody," Mr. Rich told Tom Curran, editor of Mitre Matters, *"but change has to happen. Better to have it when you want it." (Photo: Louis Leakas from* Mitre Matters*)*

V
Chemistry

Donald E. Davenport, Ph.D.'48, writes that he is assistant to the president of M.B. Associates, directing development of additives to make plastics highly conductive so they may serve as EMI shielding. This concept is valuable, he says, for computers, automobiles, and electronics and provides lightning protection to aircraft. . . . **Robert G. Ball,** S.M.'52, died on November 16, 1978, as reported by the Alumni Records Office. . . . **Warren J. Adams,** Ph.D.'70, writes, "After finishing my Course V doctorate, I moved across the river for a medical/doctorate degree from Harvard. I spent three years at Yale and am now a practicing orthopedic surgeon in Spokane, Wash.

Richard W. Eddy, S.M.'48, vice chairman of Union Carbide Europe, Inc., died in May 1980. Among his many accomplishments, he was past president of the Drug, Chemical and Allied Trades Assoc., Inc., and of the New York chapter of the Armed Forces Chemical Assoc. . . . **Douglas T. Ross,** S.M.'54, chairman of SofTech, Inc., Waltham, Mass., has received the Distinguished Contributions Award of the Society of Manufacturing Engineers.

VI
Electrical Engineering and Computer Science

Murray A. Ruben, S.M.'64, a co-founder of Data Terminal Systems, Maynard, Mass., has resigned from the board to devote more time to a new company that he is starting. . . . **Arthur J. Schneider,** Ph.D.'59, has been appointed staff vice-president at Sperry Research Center, New York, N.Y. . . . **Leon Jedynak,** Sc.D.'56, has been appointed president, corporate research and development, of Oak Industries, San Diego, Calif. . . . **Denis M. Robinson,** S.M.'31, and **John G. Trump,** Sc.D.'33, have retired as directors of High Voltage Engineering Corp., Burlington, Mass.

Robert H. Marsh, S.M.'51, died on November 18, 1975. This news has just been received by the Alumni Records Office. . . . **Frank S. Preston,** S.M.'43, writes, "I retired (early) from Norden Division of United Technologies in June, 1977. I presently teach at the University of North Carolina, Charlotte, in the Department of Analysis and Design and also manage the Engineering Cooperative Program." . . . **Peter C.M. Munasinghe,** S.M.'69, reports that he is the author of *The Economics of Power Systems Reliability and Planning*, published by Johns Hopkins Press, 1979.

Ronald E. Gocht, S.M.'58, has been elected to the post of vice-president of engineering for Scan-Optics, Manchester, Conn. . . . **Edward W. Kimbark,** Sc.D.'33, has been awarded the 1980 William H. Habirshaw Award by the Institute of Electrical and Electronics Engineering, Inc., "for advancement of electric power transmission through innovative research, classic textbooks, and inspirational teaching." . . . **Irwin M. Jacobs,** Ph.D.'59, president of the Linkabit Corp., San Diego, Calif., has been awarded the 1980 Aerospace Communications Award by the American Institute of Aeronautics and Astronautics, for outstanding contributions in the field of aerospace communications.

Myles A. Larson, S.M.'69, has been promoted from section head, command and control equipment engineering, to manager of advanced development at E-Sytems Division, St. Petersburg, Fla. . . . **L. Robert Schissler,** Sc.D.'55, has joined the staff of the Systems Components Division of Analog Devices as senior staff engineer, Norwood, Mass. . . . **Ko Muroga,** S.M.'54, reports that he was recently appointed president of N.E.C. America Inc., Melville, N.Y., a subsidiary of Nippon Electronic Co., Ltd., Tokyo. . . . **William R. Hewlett,** S.M.'36, has been named chairman of the board of the Carnegie Institution of Washington and **Edward E. David,** Sc.D.'47, has been named a trustee. . . . **Edwin S. Rich,** S.M.'48, has retired after 21 years of service to the MITRE Corp.

VI-A
Cooperative Course in Electrical Engineering and Computer Science

With 236 VI-A students scattered across the United States on work assignments this summer, the popularity of the program continues unabated. This is a 9.2 percent increase over last summer. The total 1980 summer enrollment in the VI-A

Robert Schissler

Program stands at 271, up 10.6 percent from a year ago. This spring saw the largest number of applicants (168) for admission to the program in its 63-year history.

On August 13 **Cecil Green,** '23, hosted his annual TI VI-A luncheon in Dallas. Mr. Green has just celebrated his 80th birthday on August 6 and all the TI VI-A students, their managers, and selected TI VIP's wished this illustrious VI-A'er well at this luncheon.

The IEEE recently announced **Lawrence R. Rabiner,** '64, as a co-recipient, along with **Ronald W. Schafer,** '68, of the Emanuel R. Piore Award. The citation reads "for their contributions to digital speech processing and digital filter design." Dr. Rabiner, who did his VI-A work at Bell Laboratories, has continued to support the program by supervising a number of theses of recent VI-A graduates from Bell Laboratories.

Also recently announced by the IEEE is that **Chester A. Tudbury,** '34, has been elected fellow, the Institute's highest grade of membership.

In June Mr. Tucker ran across **Theodore T.S. Wong,** '73, and his wife. Ted is currently manager of research and development at New England Research Center, Inc., Sudbury, Mass. . . . **David L. Lyon,** '69, has recently been promoted to director of engineering at Intertel, Inc., Burlington, Mass.

VI-A students continue to win many top honors. **Terence L. Chen,** '80 and **Mickey H.L. Lee,** '80 were both elected to M.I.T.'s Phi Beta Kappa chapter this spring. **Charles A. Freeman,** '79 and **Steven K. Ladd,** '81, became recipients of prestigious National Science Foundation fellowships for graduate work.

Kelly Pan, '78, has won a fellowship to attend Harvard Business School. . . . **David B. Tuckerman,** '79, has completed his VI-A work with IBM Corp.'s Watson Laboratories and has gone on to Stanford University for his Ph.D. work.

In June, Director Tucker had a visit from **Professor Herbert H. Woodson,** '51. Professor Woodson is currently head of the department of electrical engineering and director of the Center for Energy Studies at the University of Texas, Austin. "Herb" was the first Naval Ordnance Laboratory VI-A graduate to join NOL (now the Naval Surface Weapons Center and still with VI-A), going with the laboratory's magnetics division. Later he returned to M.I.T. receiving the Sc.D. degree in 1956 and served on the M.I.T. faculty from 1956 to 1971 before returning to his home state of Texas.

Also visiting the VI-A office was **Michael A. Paluszek,** '76. Mike is with the C.S. Draper Laboratory, Cambridge, Mass.— **John A. Tucker,** Director, Course VI-A, Room 38-473, M.I.T.

VII
Biology

Professor Alexander Rich, has been elected to membership into the American Philosophical Society. . . . **Victor R. Ambros,** Ph.D.'79, holds a $28,000 postdoctoral fellowship from the American Cancer Society for work on control of cell proliferation and differentiation. . . . **Cecily Cannon Selby,** Ph.D.'50, reports, "I am consulting with the North Carolina School of Science and Mathematics to set up their instructional program and now will serve as academic dean for the opening year of 1980-81." . . . **David L. Anderson,** S.M.'78, reports that he is currently researcher/assistant to the producer of the CBS News science unit.

VIII
Physics

Kenneth G. McKay, Sc.D.'41, formerly executive vice president of Bell Laboratories, has been awarded an honorary doctor of engineering degree from the Stevens Institute of Technology, Hoboken, N.J. . . . **William Shockley,** Ph.D.'36, has received the 1980 Medal of Honor from the Institute of Electrical and Electronics Engineers for his co-invention of the transistor, which has revolutionized modern science and engineering and for which he shared the Nobel Prize in 1956.

IX
Urban Studies and Planning

A career development award has come to **Lawrence S. Bacow,** '72, assistant professor of law and environmental policy, from the Office of the Provost and the dean of architecture; he will use it to further ongoing research in energy, land use, and environmental regulation. His first book, *Bargaining for Job Safety and Health*, is forthcoming from the M.I.T. Press, and Dean William L. Porter spoke for many colleagues in saying, "We consider ourselves lucky to be able to draw on his talents in areas of interest becoming increasingly important to the school and the Institute."

Paul Abplanalp, Ph.D.'68, reports that he has been appointed director of the Health Science Division of the College of Optometry at the University of Houston.

X
Chemical Engineering

Professor Clark K. Colton, a recognized pioneer in biomedical engineering, has been awarded the 1980 Curtis W. McGraw Research Award of the American Society for Engineering Education. . . . **Rene Goutte,** S.M.'61, has been named president of CertainTeed Corp.'s Insulation Group, Boston, Mass. . . . **Edward A. Mason,** Sc.D.'48, has been elected a director of the Commonwealth Edison Co., Chicago, Ill. . . . **Fred Chase,** Sc.D.'42, has retired from W.R. Grace Co. after 38 years of service during which time he was associated with Dewey and Almy Chemical Division. He and his family plan to continue living in Arlington, Mass. . . . **John F. O'Donnell,** Sc.D.'55, is currently president of Advanced Energy Dynamics, Columbus, Ohio.

Hoyt C. Hottel, S.M.'24, writes, "I have been consulting on energy problems and testified four times during the past year on synthetic fuels before Congressional committees but met with no success in terms of changing the course of developments in Washington." . . . **Peter Toong,** '40, of Harrison, N.J., died on February 4, 1980. . . . **Thomas A. Pigford,** Sc.D.'48, professor and chairman of the Nuclear Energy Department at the University of California, Berkeley, has been recommended by the American Association of Engineering Societies and the National Academy of Engineering for membership on the Nuclear Regulatory Commission.

Christian W. Knudsen, Sc.D.'69, is presently a manager of systems engineering at the Energy Systems and Technology Division of General Electric, Schenectady, N.Y. . . . **Waldemar A. Schmidt III,** S.M.'35, of Sandy, Ore., died on February 23, 1980. . . . **Robert L. Mitchell,** S.M.'47, has been elected vice chairman of Celenese Corp., New York, N.Y., responsible for the strategic planning, technology, and development activities of the corporation. . . . **Richard de Filippi,** Sc.D.'59, has been named president and

The Chemistry of Energy at the Heart of the Matter

Chemists brought it on themselves, says **John M. Deutch,** '61, Arthur C. Cope Professor of Chemistry: by making energy so abundant and cheap — and by showing us so many ways of using it — during the last two centuries, chemists have given themselves the urgent task of finding new energy resources and improving the productivity of those we already have.

Every present estimate says that the U.S. will consume more energy than it can produce — thus requiring imports — even in the year 2000, Dr. Deutch told members of the American Chemical Society in Washington last fall. How big that shortfall will be depends critically on how well we manage a series of technological challenges:

☐ Improve our energy utilization, concentrating especially on conserving energy used in transport and the domestic sector; already industry has done a great deal to increase the efficiency of its use.

☐ Learn to utilize our coal resources — in direct combustion and in conversion to liquid and gaseous fuels. Dr. Deutch noted President Carter's plan for an Energy Security Corp. to press for synfuel development.

☐ Enhance production and utilization of other conventional fuels — including secondary recovery of oil and gas and exploitation of new heavy oil and gas resources.

☐ Speed development of alternative resources — solar, biomass, and geothermal, for examples. "Good intentions are not enough," he said. "Many years of research and development will be required before we can obtain a non-negligible part of our energy needs" from these sources.

☐ Maintain the viability and improve the safety and efficiency of nuclear power. "The nuclear option has a very important role of play," Dr. Deutch said; "I personally remain very committed to it."

When he spoke to the A.C.S., Dr. Deutch was under secretary of the Department of Energy; DOE's concern, said Dr. Deutch, is to obtain diversity — many energy resources and many products. Can we mandate such a program, the way we mandate more economical automobiles? asked an A.C.S. member. No, said Dr. Deutch, he thinks not, because that invites too much government regulation. He prefers to emphasize the role of research and development on a broad spectrum of problems — thermochemistry, combustion, synfuels, for example. "The skills required are primarily those of chemists and chemical engineers," Dr. Deutch told his A.C.S. colleagues, and their success at the task is "integrally involved with our national well-being."

chief executive officer of Critical Fluid Systems, Inc., Acorn Park, Mass.

XI
Urban Studies and Planning

Francis T. Ventre, Ph.D.'73, reports that he is currently vice chairman of the Industrial and Professional Advisory Council to Pennsylvania State University's Department of Architectural Engineering. . . . **Martin I. Pitt,** M.C.P.'69, died on March 17, 1980. After studying urban planning at M.I.T., he became a partner in Zachary Rosenfield and Partners, architects and planners for health care. He also served on the Hastings-on-Hudson (N.Y.) School Board. . . . **A. Gordon Wheler,** S.M.'52, has recently commemorated his 25th year with Sterns and Wheler, Cazenovia, N.Y. . . . **Lawrence Goldblatt,** M.C.P.'75, reports that he has been doing architectural and planning work for Lawrence Goldblatt Planning and Development, "concentrating on commercial rehabilitiation of structures and urban development planning." . . . **Elaine Savitsky Chapman,** M.C.P.'70, reports, "I haven't been in the field [of planning] since 1973, when I got into individual counselling. Currently, I am doing secretarial and bookkeeping work for a CPA firm. When Jim and I migrate east this spring, I plan another shift, perhaps back to planning but possibly into some new field."

XII
Earth and Planetary Sciences

Fletcher L. Bartholomew, '50, who was a student in the department from 1942 to 1948, is now using his combined training in geology and meterology to plan airports for Howard, Needles, Tammen, and Bergendoff, Alexandria, Va. . . . **Paul D. Kaminsky,** '52, formerly with Shell Oil Co., is presently exploration geologist with Mosbacher Productions Co., Houston, Tex. . . . **Nikos Theodossiades,** '67, is currently a bank officer in the Athens (Greece) Branch of the Continental Bank of Chicago, where he is in charge of corporate credits, heads the section for multinational companies, and is responsible for the oil, gas, and mining divisions, for all of Greece.

Keeva Vozoff, Ph.D.'56, professor of geophysics in the School of Earth Science of Australia's Macquarie University (NSW), writes that "**Frances Dakin,** S.M.'68, formerly working in Ethiopia, is now married to Martin Williams, a geomorphologist/anthropologist. She and her husband are teaching in Macquarie University and also conducting research, through the University of California, Berkeley, in an NSF-sponsored program on the Upper Nile." . . . **Ferris Webster,** Ph.D.'61, formerly associate director for research at the Woods Hole Oceanographic Institution, is presently assistant administrator for research and development of the National Oceanic and Atmospheric Administration (NOAA), Washington, D.C. . . . **Raymond Harpin,** S.M.'80, reports that he has begun working as a geophysicist at Amoco Production Co., New Orleans, La.— **Robert R. Shrock,** Professor Emeritus, Room 54-1026, M.I.T.

XIII
Ocean Engineering

Stanton D. Smith, S.M.'48, is currently branch manager of Raymond, James and Assoc., Inc., Clearwater, Fla. . . . **James Soden,** S.M.'73, reports that he is presently a marine engineer at Simplex Wire and Cable, Portsmouth, N.H., responsible for installation planning for deep ocean power cables associated with ocean thermal energy conversion.

Richards T. Miller, S.M.'51, writes, "After 28 years as a naval constructor and ten years as an engineering manager in the oceanic division of Westinghouse, I am now working as a naval architect and consulting engineer in private practice. Also, I am a fellow and vice-president, technology and research, of the Society of Naval Architects and Marine Engineers. . . . **Robert P. Gill,** S.M.'72, reports that he is currently manager of naval systems applications for the LM2500 gas turbine with General Electric, Cincinnati, OH.

XIV
Economics

Margaret Garritsen de Vries, Ph.D.'46, was awarded a distinguished alumni award in April, 1980, from the University of Michigan, the university from which she received her bachelor's degree in 1943. The citation commended her academic accomplishments, her three-decade career in the International Monetary Fund, and her published volumes of history of the fund. The history volumes were cited as volumes of "meticulous scholarship, widely praised by leading economists." . . . **Thomas Carroll,** '42, has retired as president and chief executive officer of Lever Brothers Co., N.Y., but plans to continue as a director of the company.

XV
Management

Colby H. Chandler, S.M.'63, is currently president of the Eastman Kodak Co., Rochester, N.Y.; he has been a member of the Corporation Visiting Committee for the Sloan School since 1977. . . . **Vinod K. Dar,** S.M.'75, reports that he has left the consulting firm he had worked for and become a principal in Hagler, Bailly and Co., a recently formed firm which focuses on policy consulting exclusively in the energy and nonfuel mineral industries.

Leslie Rippel, S.M.'78, writes, "I still keep in touch with some '78 "Sloanies": **Laurie (Goodman) Mitchell,** is still selling tractors at International Harvester, Chicago, Ill.; **Mark Pearlman,** is at CBS doing neat things in finance and I just ran into **Tom Scott,** who just transferred from GM in Detroit to their New York office — we even live in the same neighborhood in Manhattan. I am doing media analysis for book clubs at Doubleday publishing. . . . **Howard H. Kehrl,** S.M.'60, executive vice president of General Motors Corp., has been awarded one of the highest honors ever bestowed by the Michigan Society of Professional Engineers, that of an honorary life member.

Thomas W. Finch, S.M.'62, of Lancaster, Calif., passed away in December, 1977, as recently reported by the Alumni Association. . . . **Lester H. Nathan,** S.M.'77, is currently systems analyst for Leviton Manufacturing Co., Warwick, R.I. . . . **Theodore J. Bartz,** S.M.'65, died on November 3, 1979, as his wife, Mary Bartz, recently informed the Alumni Association. . . . **Charles A. Wentz,** '75, has been named manager of oil shale and oil sands, Phillips Petroleum Co., Bartlesville, Ok. . . . **Lawrence S. Daniels,** S.M.'66, has been named vice-president, planning operations of Norton Simon, Inc., New York, N.Y.

Lawrence S. Daniels

Members of the M.I.T. Club of Hong Kong turned out en masse on May 9 to greet the 1980 Sloan Fellows on their annual overseas field trip. The pictures show Benjamin C. Kwok, '64, director of Wing On Computer Systems, Ltd., speaking as president-elect of the club (left); and (right) Abraham J. Siegel,, acting dean of the Sloan School, with Marjorie M.T. Yang, '74, director of Esiquel Enterprises, Ltd., and John L. Espy, S.M.'47, associate director of the Lingnan Institute of Business Adminstration in the Chinese University of Hong Kong. It was the Sloan Fellows' first Hong Kong visit, and it was followed by another first: ten days in China.

Elliott M. Gordon, S.M.'39, of Newburyport, Mass., died November 1979. . . . **Robert E. Smylie,** S.M.'67, has been named associate administrator for space tracking and data systems at NASA headquarters, Washington, D.C. . . . **Burt Nanus,** S.M.'59, is currently professor of management and policy sciences and director of the Center for Futures Research at the Graduate School of Business Administration of at the University of Southern California. . . . **Ilan Kusiatin,** S.M.'73, writes, "I received my D.B.A. from Harvard Business School in 1976. I am currently heading my own company which participates in industrial ventures in Israel. . . . **Ernesto J. Poza,** S.M.'74, writes that he has recently founded E.J. Poza Assoc., a management consulting firm specializing in strategy and organization. The firm has also been very active in productivity and quality-of-worklife efforts. He also has written an article describing such successful efforts published in *Organizational Dynamics* (Winter, 1980). . . . **W. Gale Cutler,** S.M.'66, has been elected to the board of directors of the Industrial Research Institute.

Jerome A. Halperin, S.M.'74, deputy director, Bureau of the Food and Drug Administration, has been promoted to the rank of assistant surgeon general in the Commissioned Corps of the Public Health Service. . . **Daniel A. Picard,** S.M.'72, has joined Lamalie Assoc., Inc., New York, N.Y., one of the nation's largest executive search firms. . . . **Edward N. Dodson III,** S.M.'61, is presently vice president of General Research Corp., Santa Barbara, Calif. . . . **Maxwell Coults,**'39, reports, "I was retired from Honeywell, Ltd., as of December 31, 1979, after 17 years of service. At the time of my retirement I held the position of director of facilities planning. My time is now spent at the museum, art gallery and church, as a volunteer. I am also travelling on a few occasions, but mostly to our country property (a converted one-room brick school house built in 1899) or to our lake property in Ontario. Also I am director of our M.I.T. Club and a member of our Educational Council — work I've been doing since 1947 and enjoying it very much."

Perry D. Cohen, S.M.'71, reports that he has established an independent management consulting practice, specializing in areas of organizational development, human resource planning and evaluation research; he completed his Ph.D. in organization studies and management in September, 1979. . . . **Charles E. Smith, Jr.,** '56, has retired from Exxon Co. and lives in the resort community of Lakeway, west of Austin, Tex. At 61, he is still doing some consulting work, part-time. . . . **Thomas Lazear,** S.M.'75, has recently created T and W Systems, Inc., Huntington Beach, Calif., to develop turnkey sytems and to provide consulting services. . . . **Robert E. Brooks,** Ph.D.'75, vice president of the research/consulting firm of Transportation and Economic Research Associates, Inc., Los Angeles, Calif., has led a major study of the nation's ability to provide adequate transportation capacity for energy materials during the period of 1985 to 1995. The results of this important study are due to be delivered to the president during the summer and should be available to the public shortly thereafter.— **Beverly J. Chapman,** Manager of External Relations, Sloan School of Management, Room E52-402, M.I.T.

XVI
Aeronautics and Astronautics

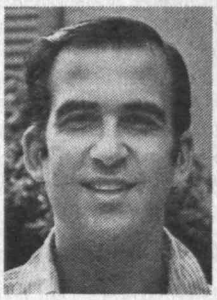
John E. Draim, S.M.'69, is currently working on classified Air Force space systems at Anser, Washington, D.C. . . . **Joseph M. Pasternack,** S.M.'38, passed away on March 9, 1980, as recently reported by his wife, Lilly Pasternack. . . . **Robert T. Drury,** S.M.'61, has been transferred from commander, U.S. Forces in the Azores, to vice commander, Military Traffic Command, Washigton, D.C. . . . **Earle L. Messere,** S.M.'64, has been appointed deputy technical director of the Naval Underwater Systems Center, Newport, R.I. . . . **Leighton J. Davis,** S.M.'41, writes that he retired from the U.S.A.F., with the rank of lieutenant general in 1968; was a member of Lockheed Aircraft from 1968 to 1975; and since 1977 has been a member of the NASA Aerospace Safety Advisory Panel.

XVIII
Mathematics

Daniel G. Quillen, professor of mathematics at M.I.T. who is internationally recognized for his contributions to new areas of mathematics, has been appointed to the Norbert Wiener Professor of Mathematics at M.I.T.

Puzzle Corner
Allan J. Gottlieb

A Prisoner Escapes, a Nobelist Wins



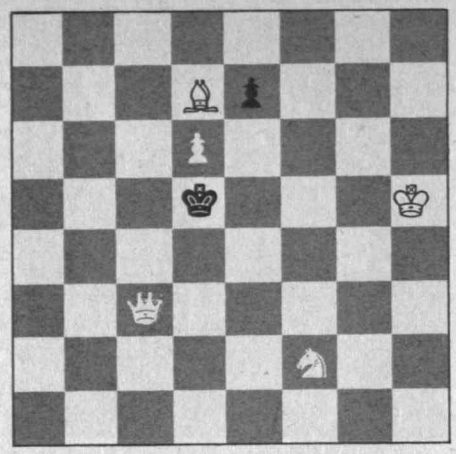
Allan Gottlieb is associate professor of mathematics at York College of the City University of New York; he studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973). Send problems, solutions, and comments to him at the Department of Mathematics, York College, Jamaica, N.Y. 11451.

I have some very cheerful news to report from one of our faithful contributors. A few years ago I described a letter I received from a reader for whom an old mathematical spark was rekindled by "Puzzle Corner." He, therefore, decided to enter college after a prolonged absence from formal education. As a college professor, I have often taught adult students; but this was the only time to my knowledge that my role as puzzle editor contributed to their number. I can now congratulate that new Brown graduate, William Butler, S.B.

G. Sharmon has asked how a computer chess program would choose between several possible mating sequences. Generally short mates are preferred; and for sequences of the same length, whichever key move was tried first would be chosen.

Problems

A/S1 We begin this installment with a chess problem that Winthrop Leeds attributes to Geoffry Mott-Smith: given the diagram in the next column, White to mate in two.



A/S2 Frank Rubin has a number theory question: Consider a set of N distinct integers, the sum of any K of which is prime. What is the maximum possible value of N for K = 2, 3, 4, and 5?

A/S3 Here is a geometry problem that was posed as an M.I.T. undergraduate challenge a few years ago:
Given four distinct points that lie on (the boundary of) a square, construct the square. Under what conditions is the square uniquely determined?

A/S4 Theodore Goodman wants you to find all the solutions to this cryptarithmetic addition problem:

```
  THREE
    TWO
    TWO
---------
  SEVEN
```

A/S5 A novel algebraic problem from Draper Kaufman:
$(3 - \log_a x)/(2\log_a x) + \log_x d = \log_x b + 2\log_x c$
Solve for x; express your answer without any parentheses or numerals, using only *one* algebraic operation (addition, multiplication, exponentiation, etc.). You may use that operation as often as you like.

Speed Department

A/S SD1 Irving Hopkins has been playing around with the googol: Given the googol, $g = 10^{100}$, and the googolplex, $G = 10^g$, let $n! = g$ (approximately) and $N! = G$ (approximately). Find n and N.

A/S SD2 R. Crandall wonders why it is that any time a chessboard Knight moves on a path terminating at its original square, the number of moves is even.

Solutions

NS19 (nee **1979 D/J5**) A solitaire game (called accordian, among other names) consists of dealing a deck, one card at a time, and then examining sets of four cards. If the four cards are of the same suit, the middle two are discarded. If the four cards are of the same value, all four are discarded. What are the odds of winning (no cards left)? What if the whole deck is laid out before starting?

This was an unusually easy NS problem, according to Jonathan Hardis, Steven Minsker,

Douglas Ell, Ed Friedman, Peter Steven, Harry Zaremba, and Judith Longyear. Mr. Ell notes that: If we let d_i = the amount the ith player starts with, after $i-1$ games he has $2^{i-1}d_i$. After i games he has $2^{i-1}d_i - (ND - 2^{i-1}d_i) = 2^i d_i - ND$. After N games he has $2^N d_i - 2^{N-1}DN$, which must equal D. Thus
$d_i = D/2^N(2^{N-1}N + 1)$.

M/A1 Find a hand where declarer's trumps are only A, 10 and dummy's only K, 7 but in which declarer can make 12 tricks against any opening lead except trump. You are allowed to specify all four hands.

The following solution is from Susan Kolodkin; she assumes that spades are trump and that the declarer is South:

	♠ K 7 ♥ A Q ♦ A K Q J 10 9 8 ♣ 9 8	
♠ 6 5 4 3 2 ♥ 2 3 ♦ 2 3 4 ♣ 2 3 4		♠ Q J 9 8 ♥ 4 5 6 ♦ 5 6 7 ♣ 5 6 7
	♠ A 10 ♥ K J 10 9 8 7 ♦ — ♣ A K Q J 10	

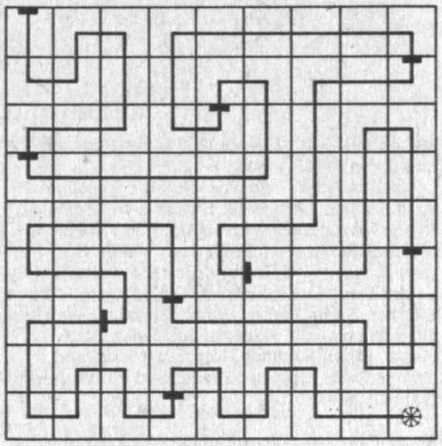
After any opening lead from East (other than trump), Declarer runs three diamonds from the dummy (only two if a diamond is led), sluffing two clubs and a heart from his hand. He then runs the ♥A and then the ♥Q, which he covers with the ♥K to get into his hand. (If a heart is led, however, the ♥A is played on the first trick.) Declarer then runs three clubs, sluffing one diamond off the board. (Again, if a club is led, only two clubs are played here and the ♥A is played to get back on the board.) Declarer then runs a third heart which is trumped by East and then overtrumped with the ♠7 on the board. Then run a diamond from the dummy which West should trump with the ♠8, allowing the Declarer to overtrump with the ♠10 and forcing East to undertrump. The Declarer then runs another heart, trumping on the board with the ♠K, and then a diamond back to the ♠A in the hand. This makes 12 tricks; the last trick is lost.

Also solved by Conrad Carlson, Carla Montgomery, John Woolston, Jack Mosinger, Kenneth Sawyer, Carey Rappaport, Harvey Fader, David Krohn, Smith Turner, Douglas Van Patter, Peter Steven, Winslow Hartford, Hal Hindman, Gardner Perry, and the proposer, Albert Fisher.

M/A2 A prisoner was thrown into a medieval dungeon with 145 doors. Nine, shown by black bars, are locked, but each one will open if before you reach it you pass through exactly eight open doors. You don't have to go through every open door, but you do have to go through every cell and all nine locked doors. If you enter a cell or go through a door a second time, the doors clang shut, trapping you.

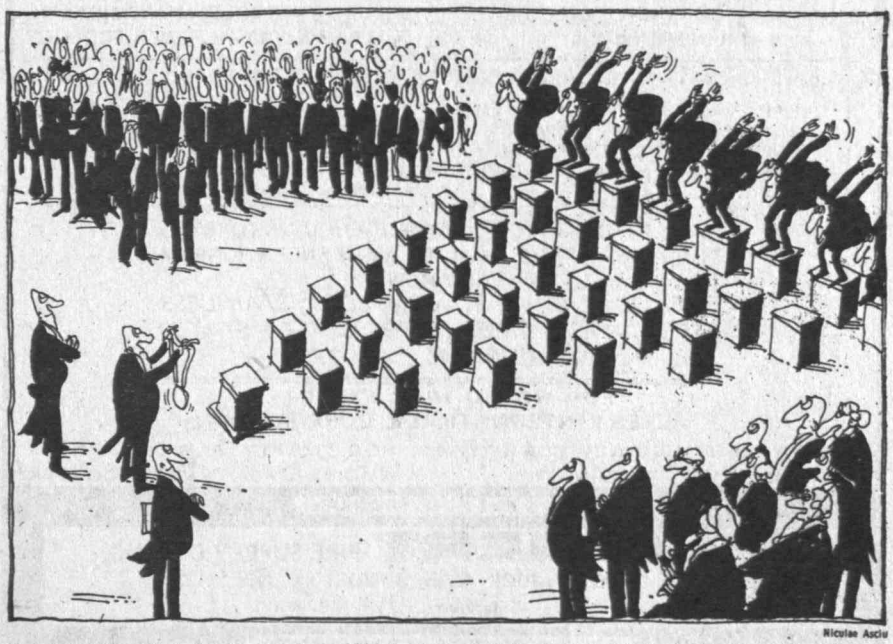
The prisoner (in the lower-right corner cell) had a drawing of the dungeon. He thought a long time before he set out. He went through all the locked doors and escaped through the last, upper-left corner one. What was his route?

For the solution to this problem, a picture is worth 1,000 words:



Solved by Gardner Perry, John Woolston, Jack Mosinger, Kenneth Sawyer, Peter Steven, Bruce Garetz, David Kates, Avi Ornstein, J. Moses, B. Rouben, Raphael Justewica, Jordan Wouk, Naomi Markovitz, and the proposer, Joan Baum.

M/A3 Given the situation shown in the drawing (below), what is each competitor's chance of reaching the winner's platform? Assume that each interior contestant may jump to one of the two nearest forward squares (50 percent chance for each) and someone on the end must jump to the nearest forward square. When two contestants land on the same square they flip a fair coin and the loser is eliminated. If this is too easy, try to find "optional strategies" for jumping right and left (instead of 50-50).



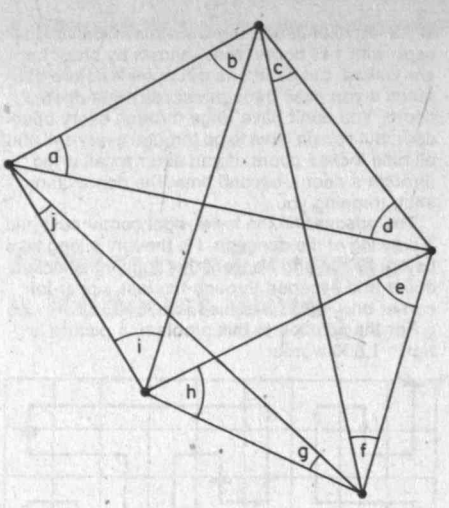
Niculae Asciu

Selecting the Nobel winners (see M/A 3 above). (Niculae Asciu from the New York Times)

This problem is still open for eight contestants and 50-50 probability. Winslow Hartford calculated the probabilities assuming that at any stage either all interior contestants jumped left or they all jumped right. Kenneth Sawyer performed the calculations for seven contestants. Finally, Glen Stoops discussed an improved strategy and calculated the probabilities for eight contestants with the modified strategy and six with the 50-50 strategy. A copy of Mr. Stoops' analysis may be obtained from the editor.

M/A4 Drawing the diagonals in a convex pentagon results in a five-pointed star. What is the sum of the measure of the angles exterior to the star and bounded by the pentagon?

The following solution is from Kenneth Sawyer: The ten labelled angles lie within five triangles. The sum of those ten angles plus the other five included angles must be 5 times 180, or 900°. But those five other angles are congruent with the five interior angles of the inside pentagon. The sum of those five angles must be (n −2)180 or 3 times



180 equals 540°. The sum of the ten angles is the difference: 900° − 540° = 360°.

Also solved by Winslow Hartford, Naomi Markovitz, B. Rouben, Peter Steven, Avi Ornstein, Bruce Garetz, Jack Mosinger, John Woolston, Gardner Perry, Conrad Carlson, Carey Rappaport, Raymond Gaillard, Farrel Powsner, Mary Lindenberg, Frank Schafer, Patty Doyle, Richard Skinner, Smith Turner, John Prussing, Reino and Christina Hakala, Raphael Justewitz, LouAnne Nesta, Steve Feldman, Norman Wickstrand, Emmet Duffy, James Landau, and the proposer, Gary Nelson.

M/A5 Find a rectilinear solid having integer-length sides, face diagonals, and space diagonal. That is, find integers A, B, and C such that $A^2 + B^2$, $A^2 + C^2$, $B^2 + C^2$, and $A^2 + B^2 + C^2$ are all perfect squares.

I had planned to print one reader's proof of the stronger fact that there do not exist positive integers A, B, C, and K such that $A^2 + B^2 + C^2 = K^2$. But now I find that $1 + 4 + 4 = 9$. I. Iverson, who is planning a book on Pythagorean triangles and Archimedean ellipses, had submitted a solution to the original problem. Perhaps s/he will resubmit that solution. As of now the problem is open.

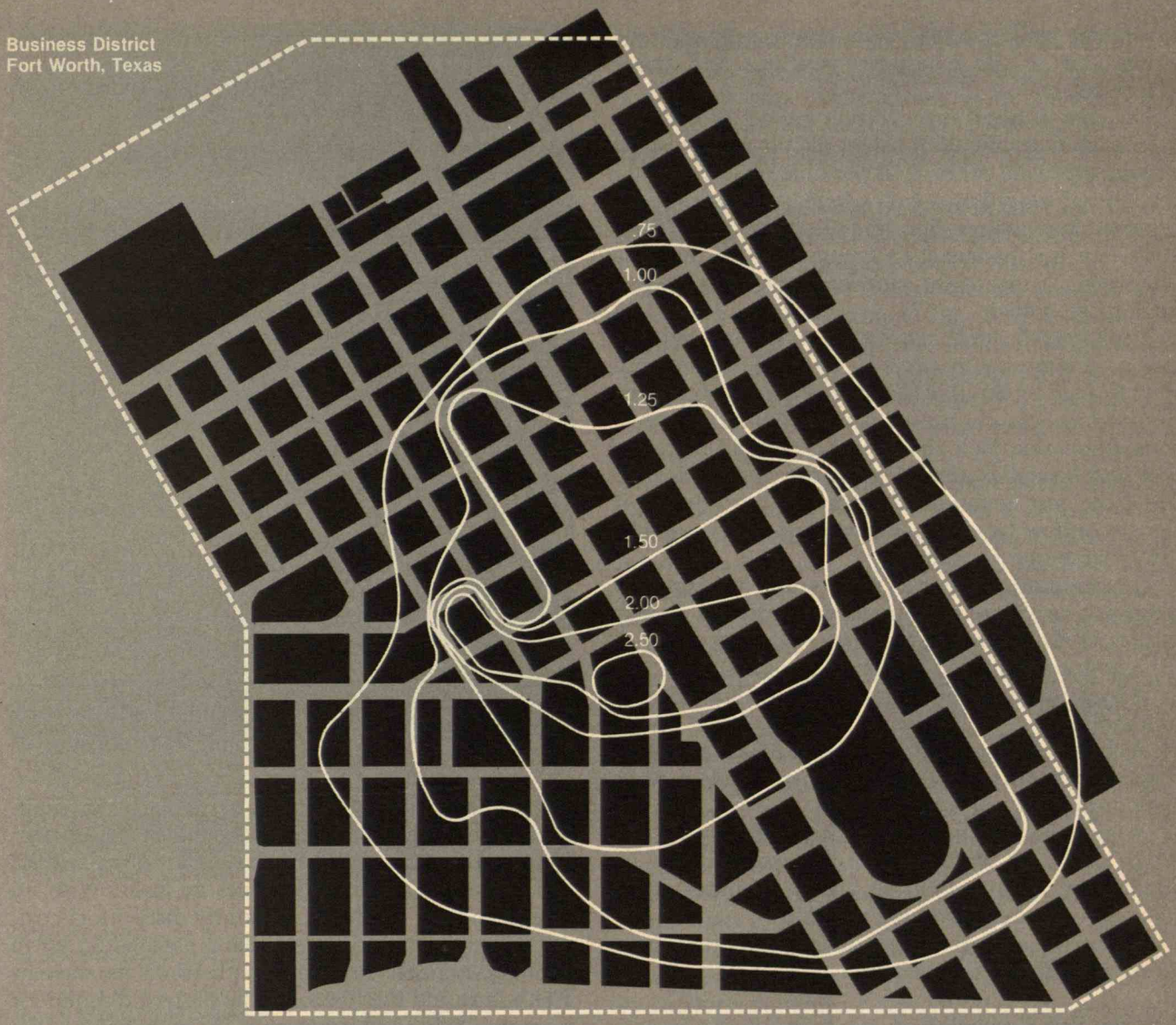
Better Late Than Never

1979 OCT5 Dennis Sandow found solutions to similar problems, such as (FOUND)(A) = KITTY.
NOV5 James Landau points out that his solution was a collaboration with Allen Beadle.
1980 D/J3 Robert Pease found a simpler solution.
D/J4 James Lefferts found an alternate form for the solution.
FEB1 Jerome Taylor has responded.
FEB3 Peter Steven has responded.
M/A SD1 Jordan Wouk and Irl Smith noted that the first phrase should be ABCDα.
MAY SD2 Half the equation was omitted. The equation should have been:
$I[x/(1 - x) = (2x - 1)\,y$.
PERM 3 Harry Hazard still maintains that the year 1789 yields 77 numbers and notes that $28 = 8/[9/7) - 1]$. Overall, he adds, "Harry Hazard has responded, cheerfully conceding that Mr. Gerling's computer is more accurate than his own pencil."

Proposers' Solutions to Speed Problems

SD1 Finding n is easy. Using a calculator (the TI SR5OA or 57), we find that 69! is $1.711224524 \times 10^{98}$, and 70! is $1.197857167 \times 10^{100}$; so we may say 70! ≈g.
For G, we may use Stirling's formula:
$X = K(2\pi N)^{\frac{1}{2}}\,(N/e)^N \approx N! \approx G$, where for $K = 1$, $X < N!$ and for $K = [1 + 1/(12N - 1)]$, $X > N!$. Then $\log X = \log K + \log (2\pi N)^{\frac{1}{2}} - N\log (N/e)$.
By cut-and-try, we find that $\log K$ and $\log(2\pi N)^{\frac{1}{2}}$ become negligible and that the nearest approximation to N is $N = 1.024838384 \times 10^{198}$, or 0.01024838384 g.

SD2 The color of the square on which the knight resides must change with each move.



A contour map of parking rates in any downtown area provides a measure of the values commuters assign to their time and convenience. In this case (Fort Worth, Texas), the contours define a slope that averages about $.25 a block, thus suggesting to the author a time/cost relationship of about $6 per hour in the decisions of Fort Worth commuters.

fort factor will, of course, vary significantly with the equipment — its condition, seating, and other amenities.

The cost of bus transportation in Fort Worth was $.35 each way. We established the marginal cost of driving a private car at $.10 per mile; we found that commuters would own cars whether or not they are required for commuting, and therefore their fixed costs are not assigned to commuting. If gasoline lines recur, a cost to the individual for this time will have to be added.

Applying all these assumptions shows that the cost of commuting by car is $7.03 per day compared with $11.05 by bus (*see the table at the right*). Clearly, most people choose to drive. Low-income persons who value their time at, say, only $2 per hour will find a smaller advantage to the private car; indeed, the cost is almost identical for bus and car if the discomfort factor is reduced in proportion to the lower valuation of time.

The standard transit bus is obviously an attractive alternative only to commuters with a strong combination of the following factors:

- ☐ A low economic valuation of their time.
- ☐ A location close to the bus so that walking time is minimal.
- ☐ A frame of mind (or job) that leads to a higher-than-average valuation of the opportunity to read or chat during the trip.
- ☐ A personal situation such that virtually all the fixed costs of a car must be assigned to its availability for commuting (the commuter must have no other real need for a car).

The survey of Fort Worth riders shows that these are exactly their characteristics.

	Private car, 1977		Transit bus, 1977	
	Cost factor	Cost	Cost factor	Cost
Transit time	0.67 hrs	$4.00	1.15 hrs.	$6.92
Headway time: Morning	Zero	—	0.5 headway plus 2 mins.	.95*
Evening	Zero	—	0.5 headway	.75*
Discomfort factor	50¢/hr.	.33	$1.50/hr.	1.73
Mileage cost	10¢/mi.	1.20	Full fare	.70
Availability cost	Parking fee	1.50	Zero	—
Total perceived cost		$7.03		$11.05

*Assumes 15-minute headway

Can the Bus Compete?

What steps should public transit take to become a viable competitor to the car?

Fare reduction is not a reasonable answer, for the fare represents less than 7 percent of the perceived cost of the trip. Discomfort and headway can be reduced somewhat, but the major cost is transit time: the cost assigned to bus transit time almost equals the total commuting cost by car.

If the bus were as fast as the car, the perceived cost of bus transportation would be only 5 percent higher than that of a car, as shown in the chart on page 47. The market available to the bus would increase dramatically, since it would now be attractive to riders who value their time at $5 per hour or less.

But to be really attractive, particularly to high-income individuals, the bus needs to be faster than the car. The table shows the results for our standard trip if the bus averages 30 miles an hour. With no change in fare, headway, or hourly discomfort cost, the bus trip would cost standard patrons $5.40 in time and expense compared with $7.03 for the car. The bus would then become the preferred mode for large numbers of commuters at the higher end of the income scale, although their higher valuation of the discomfort cost might emerge as a major factor.

Discomfort costs could probably be brought down to $1 per hour, compared with $.50 for the car. The increased volume generated by the faster and better service would require increased service with reduced bus headways; if headways were reduced to ten minutes, perceived trip cost would drop to $4.70 round trip, and the fare could be doubled with no significant increase in perceived trip cost.

These costs are for individuals who walk five minutes to the bus stop. If they drive to the bus, they could live 1.5 miles from the bus and, at 18 miles per hour, make the trip in the standard five minutes. If parking at the outlying bus stop were free, the only

	Car 1977	Transit bus 1977		
		Traveling as fast as car	Traveling at an average speed of 30 miles per hour	
			Regular service and fare	Premium service and fare
Transit time	$4.00	$4.00	$2.40	$2.40
Headway time (morning and evening)	—	1.70	1.70*	1.20†
Discomfort factor	.33	1.00	.60	.40
Mileage cost	1.20	.70	.70	1.40
Availability cost	1.50	—	—	—
Total perceived cost	$7.03	$7.40	$5.40	$5.30

*Assumes 15-minute headway †Assumes 10-minute headway

Opposite page:
To set priorities for improvements in public transportation, the author has sought to determine values in dollars for the intangibles as well as the tangibles in commuters' decisions to drive or ride. These figures are for commuters in Fort Worth, Texas, who value their time at $6 an hour and travel six miles between home and center-city offices. Under today's conditions, only commuters who value their time at less than $2 per hour will freely elect public transit.

Above:
Service improvements in mass transit — especially those that increase speed — can have a significant effect on commuters' choice between bus and private car. Using his estimates of commuters' dollar value of their time and comfort, the author concludes that to be competitive with a private car, bus service must be faster than the car and more comfortable than today. A premium service utilizing equipment similar to today's sightseeing buses, running at ten-minute headways and averaging 30 miles per hour, would attract substantial patronage and easily pay for itself if fares were doubled.

additional cost would be 3 miles per day round trip in the car, or $.30. The total trip cost is then $5.70, well below that of using the car for the total trip. This suggests the leverage that free (or low-cost) secure parking may have for increasing public transit ridership.

For distances greater than six miles from the central business district, bus transportation achieves higher speed and greater comfort advantages.

If there is doubt that high-income people would use public transportation if they had a choice, one needs only to look at the airlines. High-income people fly on their vacations because it is faster; low-income people drive because it is cheaper.

The advantages of faster bus service are even more dramatic to the transit system than to the riders. Under standard conditions, we postulated that a bus takes 1.15 hours to make a six-mile trip into town and return to its starting point. If such a bus picked up an average load of 30 passengers on the inbound morning trip and carried no passengers on its outbound morning trip, the bus would generate revenue at the rate of $9.13 per hour ($.35 fare). This revenue, which is about what is earned by a typical transit bus, covers about 40 percent of the operating costs.

If, however, the bus can make the same round trip in 0.4 hours with the same load factor and fare structure, it would generate revenue at the rate of $26.25 per hour, or approximately its operating cost. Furthermore, as mentioned, fares can be increased significantly with improved service in place. If the fare is doubled to $.70, the trip value to virtually all patrons would still be better than the car (a perceived bus cost of $5.40 compared with $7.03 by car for a standard rider), but bus revenue would increase dramatically to $52.50.

Driving Buses onto a Rising Curve

Can the improvements in speed crucial to such an optimistic scenario be realized in typical U.S. transit systems? There are a number of promising strategies:

☐ *Express service.* From any individual's point of view, transportation is point to point: travelers want to move from home to work and back again, and stops along the way are counterproductive. Bus management needs to realize the cost to patrons of stopping to pick up additional passengers. Consider this example: If there are 30 passengers on a bus who value their time at $6 per hour, then each ten-

second stop reduces the value of the trip by 1.67 cents each, or $.50 for the group. If the stop serves one passenger, the operator gains only $.35 in revenue. With multiple stops, it becomes almost impossible to attract patrons who place any reasonable value on their time. Thus, the first requirement of an attractive bus service is that it be express.

☐ *One-stop pickup*. Because express service has so many advantages, one-stop pickups at points where a large number of bus patrons can be assembled are typically successful. The Fort Worth survey showed that over half the people who had a car available but chose to ride the bus used the car to reach the bus. Instead of stopping at every corner in the pickup phase of the run, much bus service should be concentrated on supplying rapid transportation from accessible assembly points.

☐ *Dedicated right-of-way*. A right-of-way dedicated to buses and free of other traffic greatly reduces bus transit time. Such right-of-way implies that the bus is freed of the need to stop at traffic lights for cross traffic, and to capitalize upon a dedicated right-of-way, the bus must also be relieved of the need to stop at every corner to pick up passengers. While obtaining new rights-of-way in urban areas is almost prohibitively expensive, it is often feasible to build or designate bus routes at specific congestion points such as bridge or tunnel entrances.

☐ *Signal preemption*. With a traffic signal preemption system, the operator of a transit bus can signal ahead to give the bus right-of-way as it approaches traffic lights. Because cross traffic is then no longer a major problem, signal preemption combined with special bus lanes becomes a viable option for providing higher-speed bus service on existing roads.

☐ *More frequent service*. More frequent service is desired by all, but is, of course, dependent on volume. If the other strategies are successful, they will build the volume necessary to improve frequency, which begets more volume.

By adopting all these strategies in concert, we can postulate average transit speeds of 30 miles per hour, with buses faster than cars.

There are also important unrealized options for improving comfort. Transit buses are currently designed with narrow seats and wide aisles to make entrance and egress easy and to accommodate standees. But since each standee is a lost patron, and patrons of efficient transit systems would generally be boarding and disembarking at only a few stops,

(Article continues on p. 52)

Those Big Red Double-Decker Buses

by Robert E. Machol

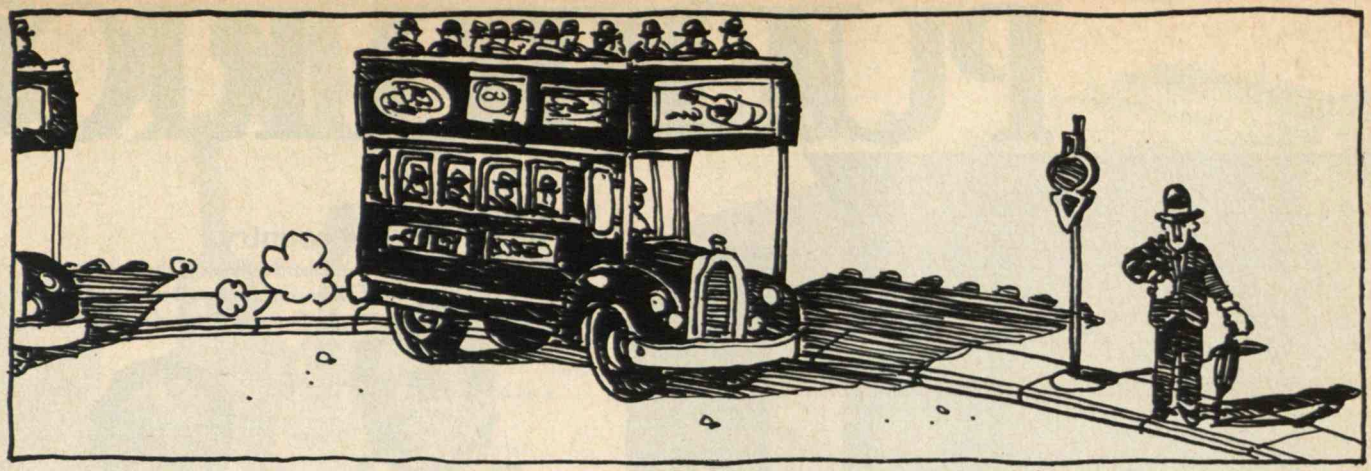
London's buses and Underground carried 1,870 million passengers 5,600 million miles in 1978, for which they collected fares of £335 million. As a resident of London, I contribute some of those passenger miles, so when I went to visit the Operational Research Group at London Transport, it was not only to learn about their studies but also to take the opportunity to express my own personal disgruntlement with the bus service.

London Transport, which runs both the buses and the Underground, reports to the Greater London Council and obtains its subsidies therefrom. Its Planning Department includes a Planning Research Office headed by Derek John Wagon, with eight economists, twelve operational researchers, and eight support people. Wagon has an M.A. in mathematics from Cambridge, and that may account for his observation that "economists do better than operations research (OR) types; they tend to be policy oriented, while the OR people tend to deal in the nitty-gritty." More of his group's effort is spent on economics than OR, and more is spent on bus than on rail. The latter is partly for historical reasons, but also because there is more flexibility in what one can do with buses. Most of the group's effort is devoted to collection and interpretation of data rather than to the more conventional OR concept of quantitative studies leading to specific recommendations for decision makers.

A Matter of Time

Wagon and his group have developed several quality service indicators (QSIs) for both rail and bus service. From previous research (largely performed by others) they are well aware of people's utility functions. For example, passengers are much more willing to sit on trains and wait than they are to sit on platforms and wait; they apparently value the former about twice that they value the latter. What customers value most for short trips is short waiting time; for long trips people tend to be more interested in low fares. Wagon does not appear to be interested in my principal frustration — namely, that after waiting an unconscionably long time for, say, a #27 bus, two or three #27 buses come along bumper to bumper. I suppose this bothers me because it represents a delay that might have been avoided by better management. It doesn't bother Wagon because he believes that customers are interested in the bus they get onto and don't care what comes after it. It is well known that there is a natural tendency for buses to bunch: even if they are started with uniform headways, there will be random fluctuations. When two buses get close to each other, the one in front picks up most of the passengers and therefore goes more slowly, while the one in back picks up fewer and goes more rapidly. As Wagon pointed out, the only way to avoid this is by slowing things down; that is, while leap-frogging helps a little, you can't speed up the bus in front. All you can do is hold back the one behind — albeit somewhat delayed from the original schedule. This is practically impossible except at the terminals and could meet with union intervention, a variable hard to quantify.

There would be some waiting time even if operations ran perfectly, so what Wagon's group measures is the extra waiting time — namely, the average waiting time per passenger less what the average waiting time would be if



things were perfect. The difference may have either or both of two causes: the number of vehicles running is less than scheduled (caused either by a shortage of vehicles or staff), or there may be deviations from schedule due either to traffic congestion or to bunching.

Waiting for a Full Bus

There are well-known variations of this extra waiting time with time of day, day of week, and time of year. For example, waiting time tends to be about three minutes during the summer and four minutes during the winter. These numbers, which have been growing slightly larger each year for the past several years, measure only the time until the next bus comes. It turns out that 10 percent of the time the next bus is full and the passenger isn't allowed to board the bus when it does arrive, so the actual wait is longer than indicated. Again, this is worse in the winter (about 11 percent) than in the summer (8 percent).

The latter situation has improved each year for the last few years; that is, the probability that the bus when it does arrive will be full was smaller in 1979 than it was in 1978, and in turn that was smaller than in 1977. Unfortunately, the probability that when a bus arrives it will be full is measured from the viewpoint of the bus. From the viewpoint of the passenger the probability is considerably larger, because there are more passengers around when the buses are full than when the buses are empty. Thus, the probability that the first bus that comes when I am waiting is full exceeds 10 percent. This type of paradox is familiar to statisticians.

Wagon and his group have also measured the probability of waiting more than 10 minutes. This would be about 0.05 if everything were on schedule. It is actually almost 0.3; of course, this includes periods of low patronage (such as Sunday) when the waiting times are much longer.

Before deciding what to do with data such as these, one must determine the measure of effectiveness. (It is clear that the objective is not simply to make a profit; London Transport has a significant loss each year. Fares pay only about 70 percent of the short-term cost of running the buses and 90 percent of the short-term cost of running the rail system.) The measure chosen has been the number of passenger miles generated, and Wagon and his group even know what the elasticities are: at the margin it costs between £0.20 and £0.30 to generate one extra passenger mile. One can argue about whether to measure passenger miles or passengers: passenger miles tend to emphasize longer trips, and there is some indication that the longer trips tend to be taken by wealthier people. On the other hand, measuring passengers tends to emphasize shorter trips, which in turn emphasizes services in the downtown area, and surely one of the objectives must be to maintain access to central London rather than letting it disintegrate (as has happened to central cities in other parts of the world). But however you measure effectiveness, the bottom line is that the better the service, the more people will use the facility.

One Operator or Two?

Some London Transport buses, especially those that do not go into central London, are operated by a crew of one rather than the two with which most tourists are familiar. Eliminating the conductor, of course, saves money, but it also slows the bus, and eventually more buses and more drivers must be provided to offset the reduction in service. Wagon and his group have determined that it takes from 3.5 to 4 seconds to get a passenger on a one-operator bus, but this can be reduced to 2 seconds if there is a flat fare independent of trip duration. With a two-operator bus, boarding a passenger takes about 1.2 seconds.

Given all this data collection and interpretation, I was surprised at how little these data were used to make specific operational recommendations. One case in which the OR group did provide significant input was in choosing fare policies. Specifically, they have identified the higher marginal benefits from improving off-peak services, and Wagon is convinced that from this alone they have more than earned the £250,000 year that the group costs.

Based on the criteria described above, the group has computed that it would be worth about £20 million per year to bring the extra waiting time from four minutes to three. They have also computed that it would cost a good deal more than that, so they are not planning to do anything about it.

I was pleased to discover that Wagon is a fellow rider. There is no car park at the headquarters for London Transport's Administrative Operations, so most employees use London Transport. However, the executives, who perhaps might learn from riding the buses and tube, are generally chauffeured to work. At the suburban installations there are large free parking spaces for LTA employees; such parking has been found essential for recruiting.

Doing operations research for London Transport tends to be a discouraging task. Almost every improvement costs money they can't get, and other factors such as union agreements may militate against it.

In spite of this, public transport in London is a pleasure compared with that in any city in America that I know.

Robert E. Machol is professor of systems in Northwestern University's Kellogg Graduate School of Management. He is on leave as liaison scientist in the London office of the U.S. Navy Office of Naval Research, from whose European Scientific Notes *this report was adapted.* □

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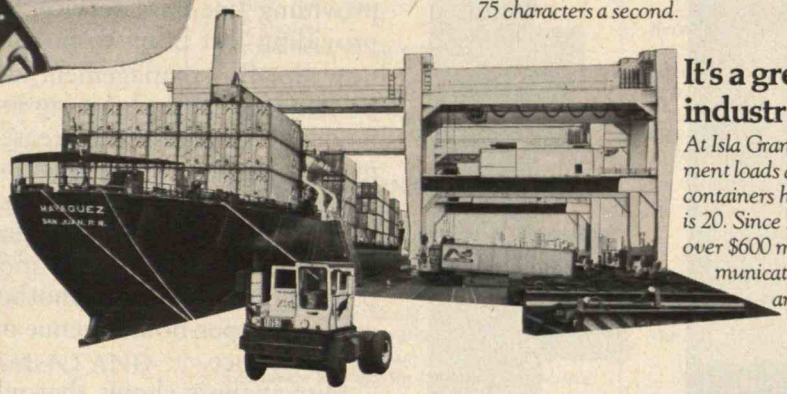

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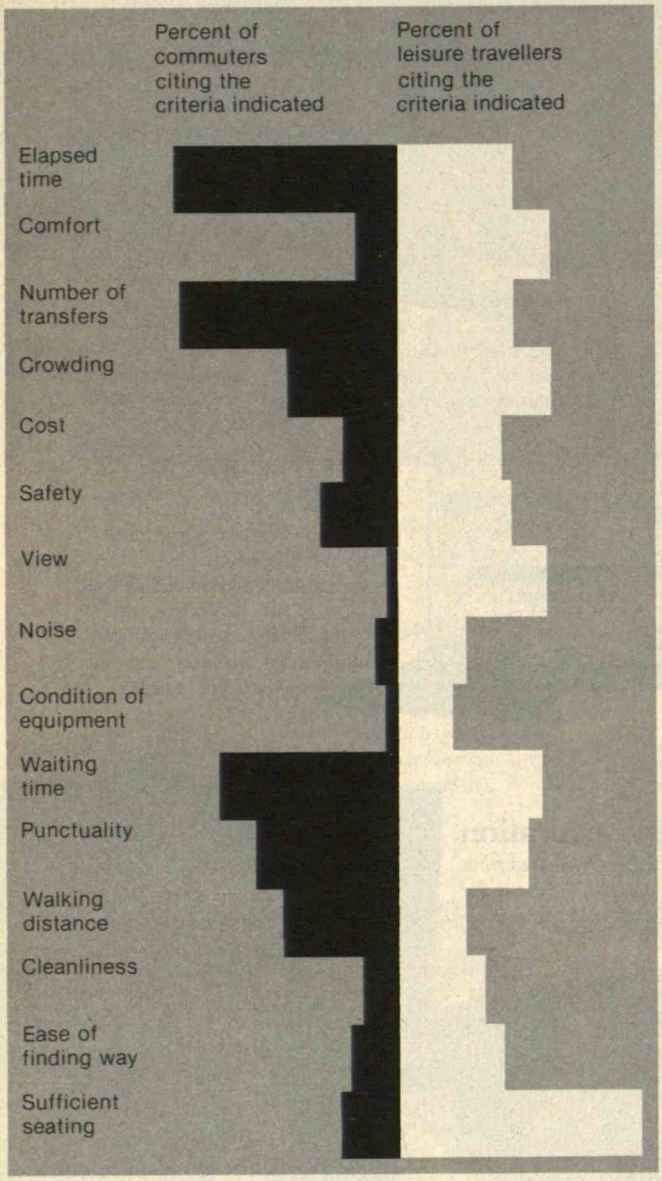

The author's argument that "speed is the name of the game" in public transportation for commuters in Dallas, Texas, is remarkably consistent with the results of a 1974 survey of Japanese travellers conducted by the Japan Transport Economics Research Center. For its survey, the Japanese center divided travellers into several categories based on their purposes in travelling; for commuters, time-related factors were clearly the most important. (*Chart adapted from The Wheel Extended [Toyota Motor Sales Co., Ltd.], Autumn 1979*)

the future transit bus can be designed with wider, more comfortable seats and narrower aisles. A parcel rack for briefcases and small packages should be provided. Such a bus, with all seats facing forward, would look like today's sightseeing bus.

A Message to Management

There are some important lessons in this analysis for transit management. Bus companies should constantly remember that speed is the name of the game. Management needs to shift its emphasis from providing line-haul service, as the railroads do, to providing fast point-to-point service as the airlines now do. Bus management should also reorient its priorities toward obtaining increased revenues. The tendency has been to increase per-mile revenues by making frequent stops, packing more people in each bus and forcing many patrons to stand. Instead, the emphasis should be on bringing each bus to its destination faster so it can more quickly load new passengers and make another trip. This both increases the per-hour revenue of the bus and the value of the service.

Our analysis shows that with implementation of these concepts, and the cooperation of other municipal agencies in providing bus lanes and permitting signal preemption, bus transportation could profitably recapture a reasonable portion of the commuter market. In many U.S. cities, all parties can win only by adopting policies for speeding bus transportation, thereby attracting more riders. Moreover, one improvement leading to greater patronage can spawn more improvements and — in the end — increase patronage even further.

Jack C. Page is president of Jack C. Page, Inc., management consultants of Dallas, Texas. He studied mechanical engineering at M.I.T., receiving his S.B. in 1948. Before forming his own company in 1972, Mr. Page was with Booz, Allen and Hamilton, Inc., most recently as vice president in charge of the Dallas office.

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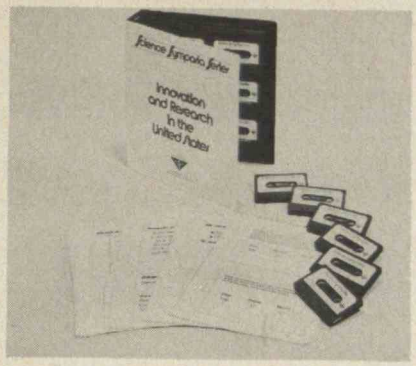

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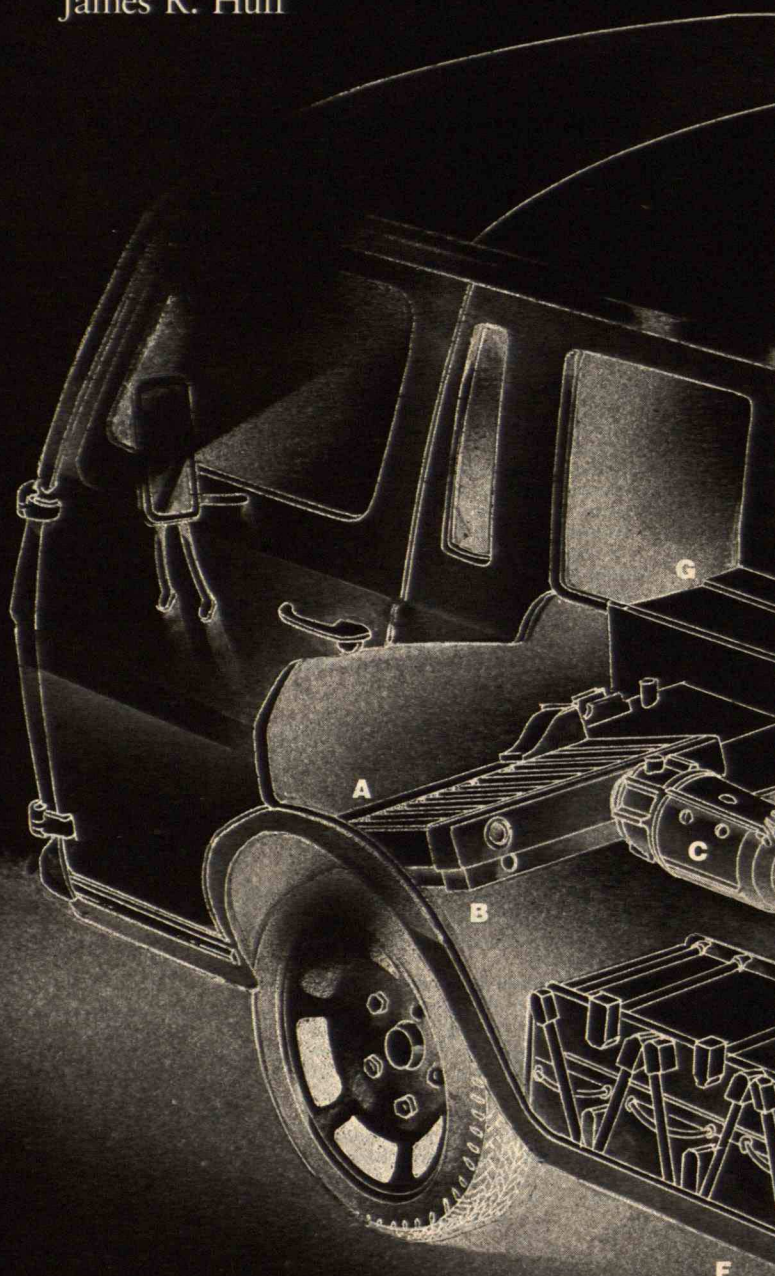
The Case for Fuel-Cell-Powered Vehicles

by J. Byron McCormick and James R. Huff

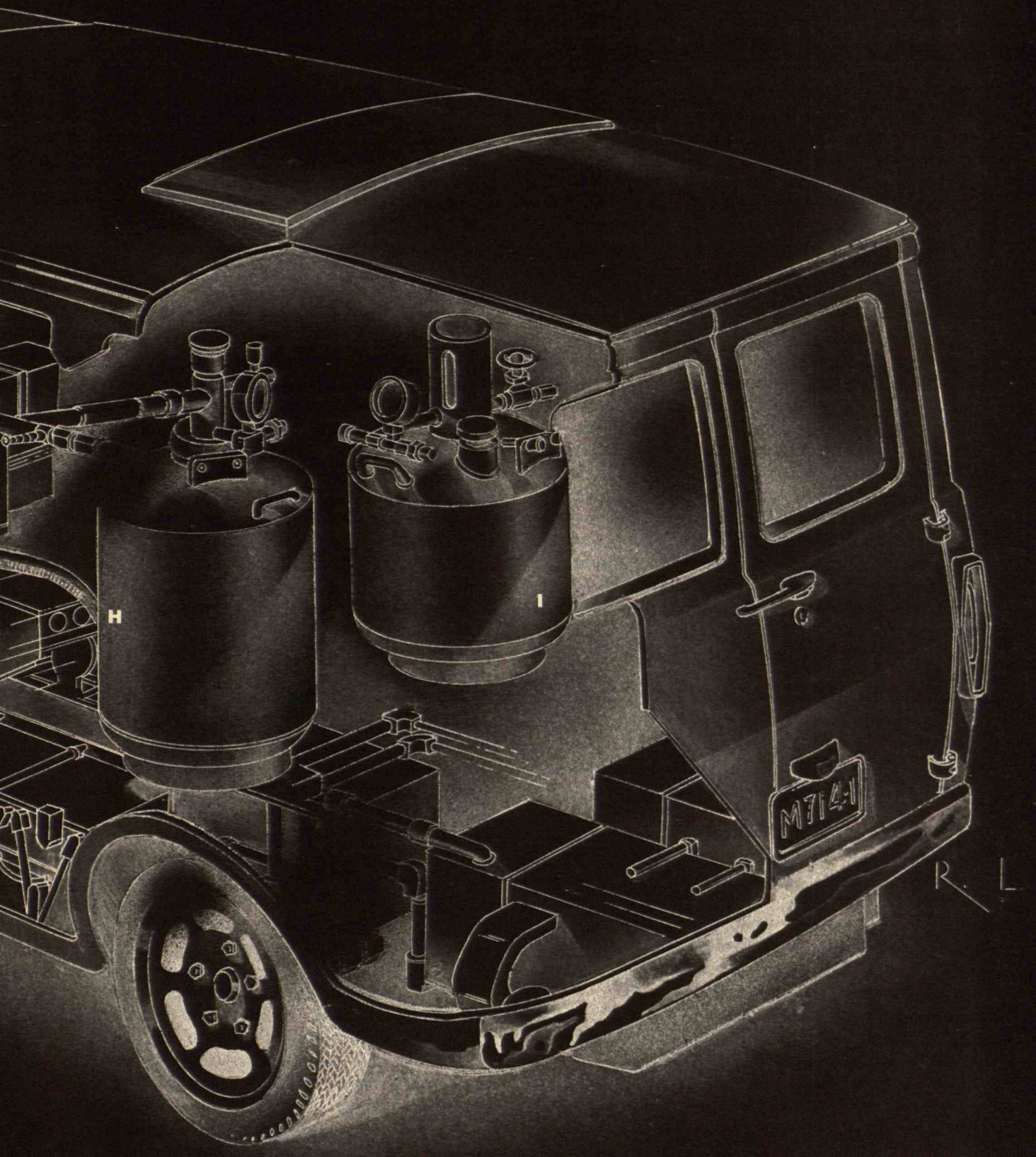


The General Motors Electrovan, the first fuel-cell-powered automotive vehicle. This demonstration unit was built in 1966. The power plant consisted of 32 "modules" connected in series to produce a continuous output of 32 kilowatts, enough to propel the 7,100-pound van to a speed of 70 miles per hour. However, the toll of 3,930 pounds of fuel cell and power train was heavy and acceleration rather leisurely — from 0 to 60 miles per hour in 30 seconds.

A: Water Condenser
B: Electrolyte Radiator
C: AC Induction Motor
D: Gearbox
E: Electrolyte Reservoir
F: 32 Fuel-Cell Modules
G: Motor Controls
H: Liquid Hydrogen Tank
I: Liquid Oxygen Tank

In the next few years, automakers will continue to emphasize smaller, lighter, more economical vehicles. Electric vehicles could be prominent in this future, and on-board fuel cells could be an appropriate source of their electricity.

Fuel cells are highly efficient, nonpolluting electrochemical devices in which the energy in a chemical reaction between a fuel and an oxidant is catalytically converted into electricity (*see diagram on p. 57*). Unlike chemical storage batteries in which limited chemical energy is stored *inside* the cell, fuel cells utilize fuel and oxidant stored *outside* the cell. A fuel cell will produce electricity as long as fuel and oxidant are supplied.



Fuel cells do not produce particulates or unpleasant exhaust odors, a definite asset for urban buses. And they are immune to diesel fuel supply problems.

Fallout from Space

The fuel cell is by no means a new device. In 1802 the English chemist Sir Humphrey Davy built a fuel cell that used carbon electrodes and nitric acid electrolyte and operated at room temperature. In 1839 Sir William Grove, another English chemist, made the first hydrogen-oxygen fuel cell. In 1894, with remarkable vision, Wilhelm Ostwald, a German chemist, suggested that the development of energy-conversion technology should emphasize electrochemical processes instead of combustion. He theorized that electrochemical conversion techniques could convert a reaction's entire free-energy exchange (the difference between the energy stored in the chemicals entering the reaction and the energy stored in the products of the reaction) directly into electricity. The technique theoretically could sidestep the constraints imposed by thermodynamics (which limit the amount of mechanical work that can be obtained through thermal conversion), and he emphasized the prospective gains in energy conversion efficiency. Ostwald also foresaw the dangers of increasing urban air pollution from continued use of combustion. But electrochemical phenomena were not generally understood at the time, and his electrochemical strategy was never implemented.

Interest in fuel cells lay dormant until the 1930s, when working models of several different types were built; but it soon became evident that these devices were not sufficiently durable or powerful to compete effectively with heat engines and conventional generators. In 1946 the Soviet scientist O.K. Davtyan built a hydrogen-oxygen fuel cell that used both liquid alkaline and solid electrolytes. The results of his investigations were promising, but the cells were delicate and produced too little power to be practical.

Two separate efforts in 1959 demonstrated that fuel cells could be practical, controllable energy converters. After 20 years of research, F.T. Bacon of Cambridge University constructed and demonstrated a 6-kilowatt, hydrogen-oxygen fuel cell, forerunner of those used for primary power in the *Apollo* space flights. In the U.S., Allis-Chalmers Manufacturing Co. demonstrated a farm tractor powered by a 20-horsepower, 15-kilowatt, hydrogen/propane-oxygen fuel cell, to become the predecessor of *Apollo*'s backup power source.

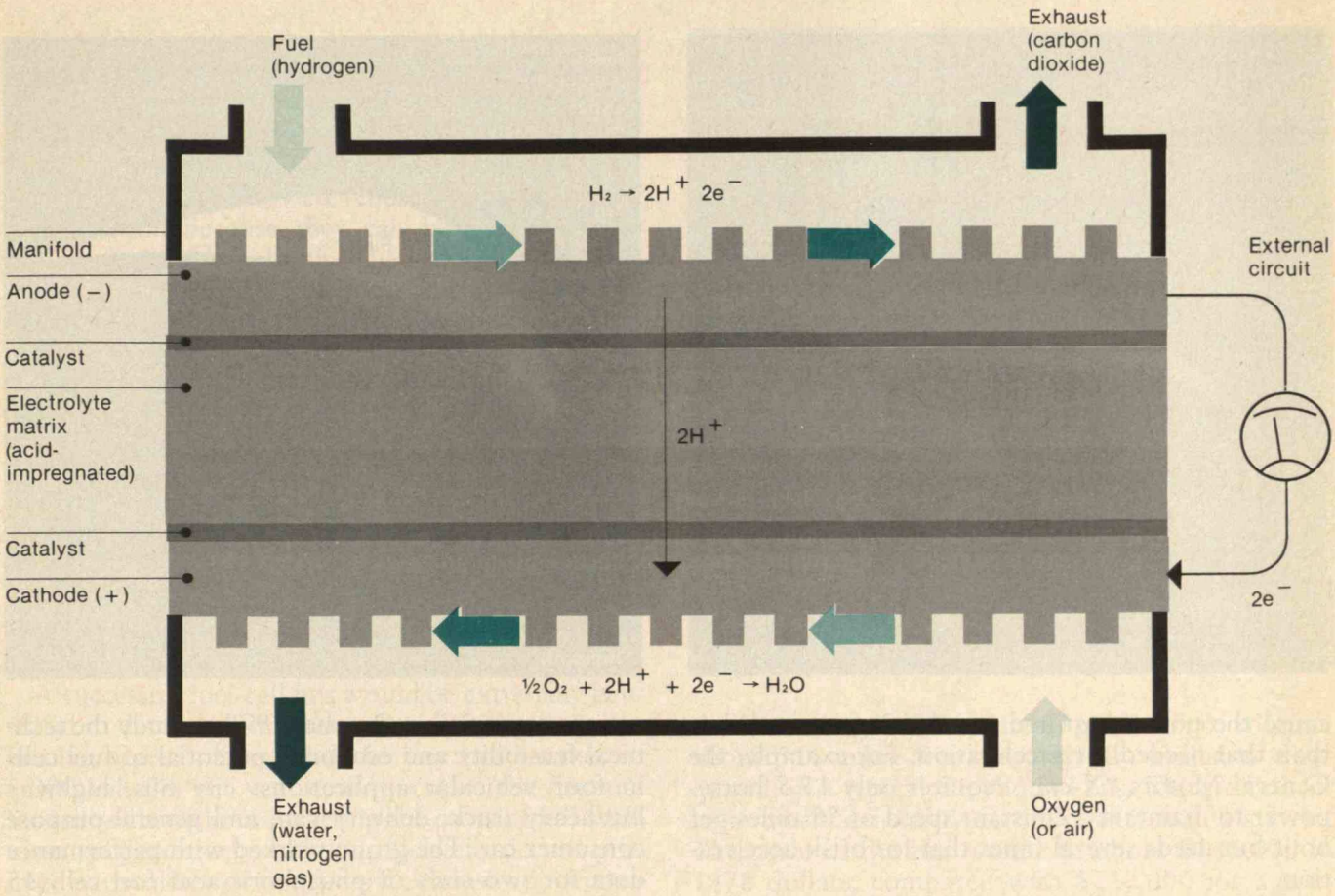
The high cost and physical limitations of materials, especially in relation to corrosion, were vexing but approachable problems, and the 1960s were an era of intense research into fuel-cell design. The space programs provided incentives for significant funding of fuel-cell research in NASA, other government agencies, and private industry. The fuel cells in the space program proved they could produce electricity efficiently and perform well over a wide range of loads. The development of fuel cells that use phosphoric acid as their electrolyte led the Electric Power Research Institute (EPRI), the Department of Energy (DOE), and United Technologies Corp. to focus a collective effort on developing a modular 4.8-megawatt-electric (MWe) fuel cell for use in utility power plants. Of particular interest in this development has been the low pollution levels produced by these power plants.

Today's phosphoric-acid-electrolyte fuel cells have power densities (output per unit volume, weight, or electrode area, depending on the focus of such an assessment) and projected costs and lifetimes (40,000 operational hours) commensurate with utility needs. Preliminary research and development has led EPRI and DOE to suggest that this type of fuel cell has "excellent prospects for evolutionary advances that project . . . better efficiencies and lower costs." These projected performance characteristics also make fuel cells very appealing for automotive applications.

Fuel Cells on the Road

During the late 1960s, two fuel-cell-powered vehicles were constructed and tested in the United States. The performance of the vehicles was limited by the low power density of the fuel cells and by starting problems.

A van built by General Motors was powered exclusively by experimental fuel cells using alkaline (potassium hydroxide) electrolyte. The cells, assembled in 32 individual modules, used cryogenic liquid hydrogen and oxygen that were carried on board. A second vehicle, built by Karl Kordesch of Union Carbide, used a six-kilowatt alkaline fuel-cell assembly augmented with storage batteries, a significant innovation. The batteries, in parallel with the fuel cells, provided peaking power; excess fuel-cell output was used to recharge the batteries during low power and "idle" periods. Air was used instead of cryogenic oxygen. This type of fuel cell could be polluted by carbonates precipitated by the reaction of the electrolyte and carbon dioxide — Kordesch used soda lime scrubbers to remove carbon dioxide from the air. Gaseous hydrogen was utilized for fuel



and stored in tanks on top of the vehicle.

In 1977, spurred by the rising costs of petroleum and dramatic results achieved by utility fuel-cell programs, the Energy Research and Development Administration's Divisions of Transportation Energy Conservation and Conservation Research Technology sponsored a workshop on fuel-cell vehicles at Los Alamos Scientific Laboratory. Representatives from the fuel-cell industry, the automotive industry, other national laboratories, and several universities evaluated the potential of a hypothetical hybrid vehicle powered by a fuel cell paralleled by batteries in a configuration similar to the Kordesch vehicle. Participants concentrated on a fuel cell using phosphoric-acid electrolyte, having concluded that cells using other electrolytes would require additional development and "would be inappropriate in initial evaluations." In this all-electric system, the fuel cell was to provide power for a steady cruising speed of 55 miles per hour; the battery would provide power during the 15-minute period presently necessary for fuel-cell warm-up and acceleration. This approach is particularly appealing be-

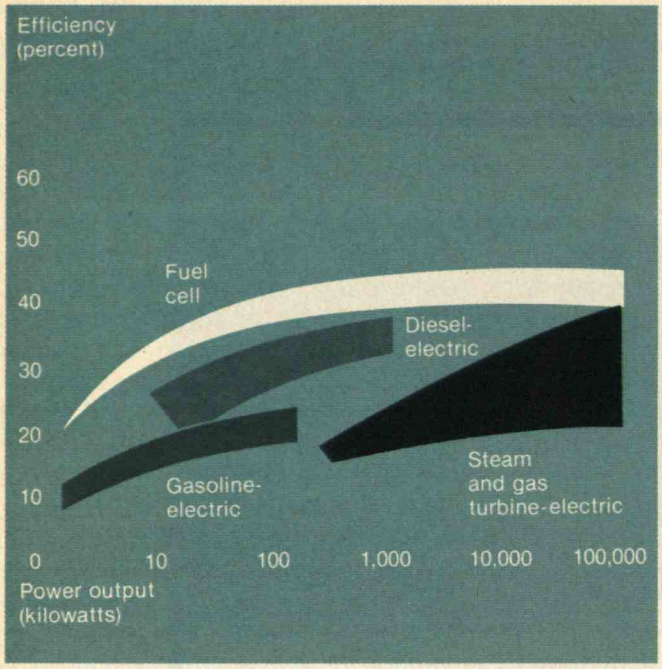
A diagrammatic cross-section of an acid-electrolyte fuel cell. The operating principle of this, the simplest and most highly developed type of fuel cell, is fundamentally a reversal of the electrolysis of water. Instead of passing electricity through water to produce hydrogen and oxygen, hydrogen and oxygen are combined at the surface of electrodes to produce water and electricity.

The active parts of the hydrogen-oxygen fuel cell consist of two porous carbon electrodes (each with a catalytic layer) separated by a blotterlike, porous matrix impregnated with the acid electrolyte. Hydrogen gas is passed over and through the anode, where it contacts a catalyst and becomes ionized, producing two electrons per molecule of gas. The electrons flow through an external circuit — where the practical electrical work is done. The electric circuit is completed by ionic conduction through the electrolyte. The overall reaction produces water at the cathode.

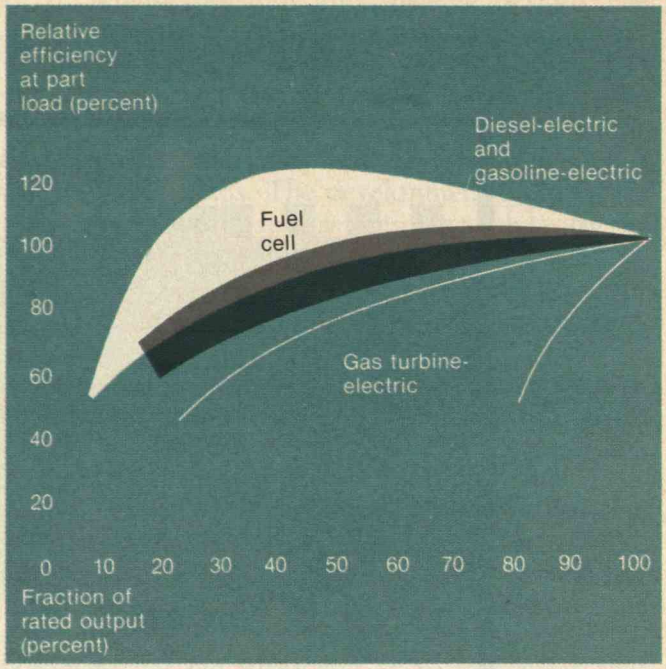
When air is used as the source of oxygen, atmospheric nitrogen gas passes through the cell and emerges as part of the cathodic exhaust stream; when organic fuel stocks such as methanol are used as a source of hydrogen, the carbon dioxide that is also produced emerges in the anodic exhaust stream.

Each individual fuel cell produces about 0.6 volt at nominal operating currents, and in practice several cells are combined in series within a module case to produce higher voltage and power.

Below: One advantage of fuel cells is their high thermal efficiency. The graph shows the efficiency of electric generation by various means at full rated capacity, typical of utility applications. Included are fuel cells and conventional generators powered by diesel engines, gasoline engines, and steam and gas turbines. Fuel cells are clearly the most efficient of these options.



Below: Fuel cells used to power vehicles would operate at part load a great deal of the time. The graph shows the relative thermal efficiencies of fuel cells, conventional generators powered by diesel engines, gasoline engines, and gas turbines generating electricity at part load.



cause the power required for cruising is much less than that needed for acceleration. For example, the General Motors "X-car" requires only 15.5 horsepower to maintain a constant speed of 55 miles per hour but needs several times that for brisk acceleration.

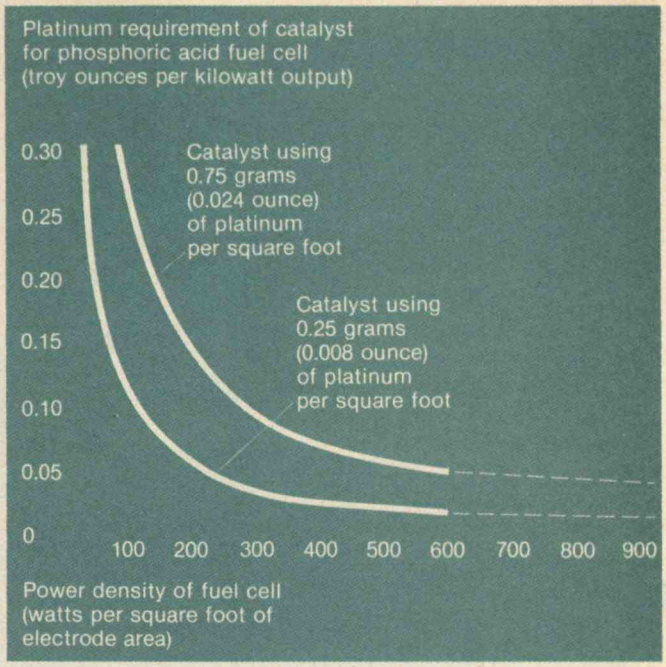
Although any source of hydrogen could be used to provide fuel, the workshop concluded that the best near-term fuel would be coal-derived methanol (methyl alcohol). Methanol can also be made with existing technology from biomass. The methanol, mixed with an equal amount of water, would be catalytically converted (a copper-zinc catalyst is used), or "reformed," aboard the vehicle into the hydrogen needed for the fuel cell and carbon dioxide. Such a methanol reformer operates effectively at approximately 200° C — about the same temperature at which the fuel cell operates. Presently the reformer is preheated by burning some of the fuel mixture. Under development is a method by which waste heat from the fuel cell is used to preheat the fuel entering the reformer, increasing overall energy efficiency. The technology of reformers was considered well developed by workshop participants.

Building on the optimism generated in 1977, the Brookhaven National Laboratory, the U.S. Army Mobility Equipment Research and Development Command (MERADCOM), and the Los Alamos Scientific Laboratory jointly carried out an "applications scenario" in October 1978 to study the technical feasibility and economic potential of fuel cells in four vehicular applications: city bus, highway bus/heavy truck, delivery van, and general-purpose consumer car. The group worked with performance data for two sizes of phosphoric-acid fuel cell (15 and 60 kilowatts) and considered two fuel options (methanol and propane). In all cases, it was assumed that batteries would be used for power while the fuel cells warmed up and would be recharged by the fuel cells whenever their output exceeded their load. Drive-motor speed would be controlled with conventional controllers used in electric vehicle applications.

Fuel-cell power was found to be technically feasible for all four vehicles studied. Economic viability was more difficult to prove because of the scarcity of data on fuel-cell performance and economics in the vehicular environment. However, conservative estimates (improvements in fuel cells, batteries, motors, and vehicle aerodynamics were not assumed) led participants to suggest that fuel cells could power vehicles economically in the 1990s.

☐ *City Buses.* One goal of the "applications scenario" was to design a 40-foot-long, 26,000-pound fuel-cell-powered bus that could perform as well as a diesel-powered version and thus meet the Department of Transportation "Baseline Advanced Transit Coach Specifications" for 1977, by which performance acceptability for federal subsidy is de-

How the platinum requirement of fuel cells would decrease with enhanced power density. The upper curve shows the platinum requirement for a fuel cell having an electrode containing 0.75 grams per square foot; the lower curve, that for a fuel cell having an electrode containing 0.25 grams per square foot. Techniques to improve power density show great promise, and catalysts of new materials requiring no platinum are now on the horizon.



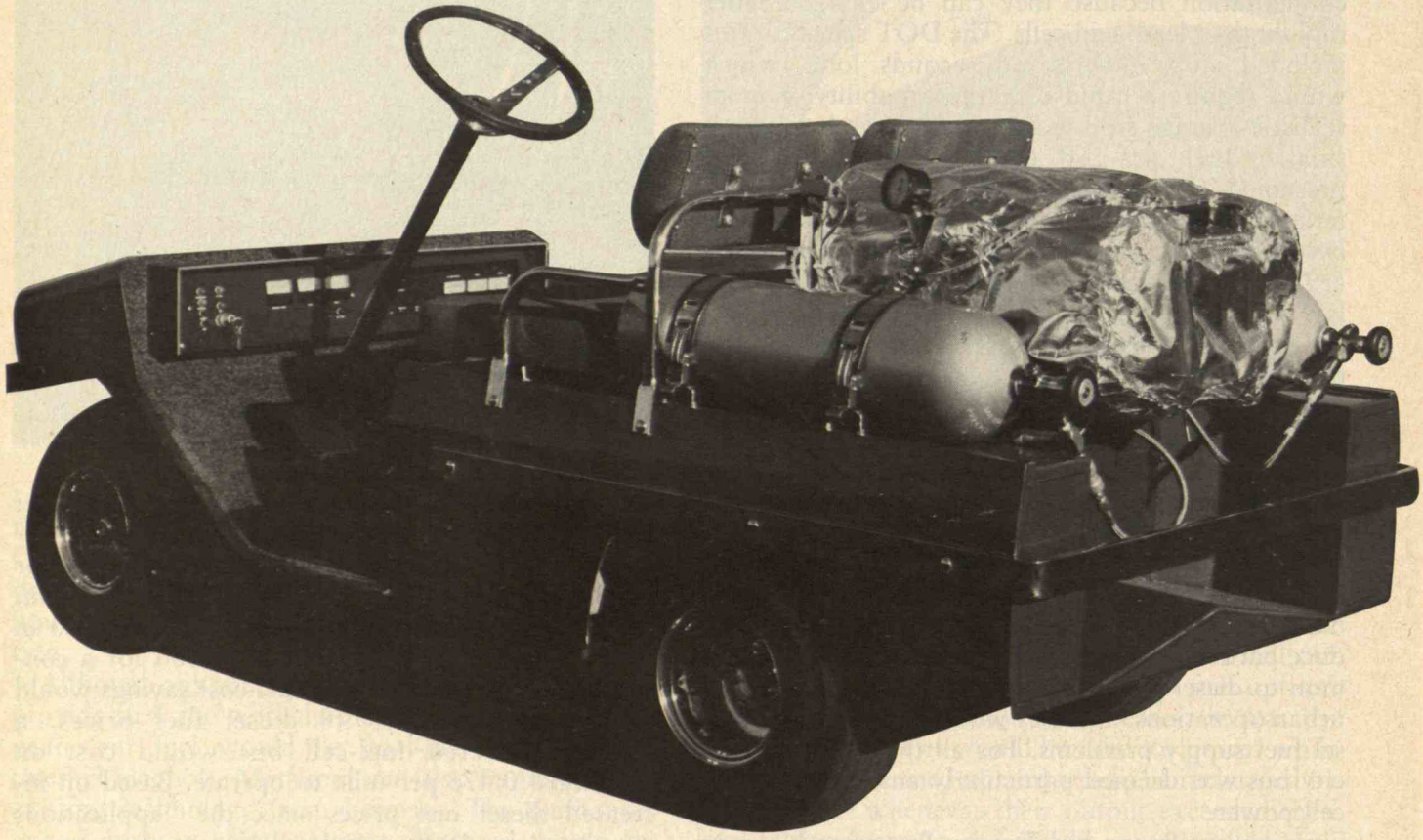
termined. It was calculated that such a bus would require an 86-kilowatt fuel cell in parallel with storage batteries providing 34 additional kilowatt-hours for acceleration. Excess electricity from the fuel cell would charge the batteries, chiefly during stops. Nickel-zinc batteries were chosen for the hybrid configuration because they can be charged more rapidly than lead-acid cells. The DOT specifications included stops only seven seconds long, which would require a rapid recharge capability; a more realistic average stop would allow for a bus with a smaller fuel cell (60 kilowatts of power was presumed sufficient) and cheaper, lead-acid batteries. The sticker price of this fuel-cell/battery-hybrid-powered city bus was estimated at $124,000 (1978 dollars), compared with $100,000 for a similar diesel-powered vehicle. But since 80 percent of the cost of procuring city buses is now subsidized by the federal government, the price disadvantage of fuel-cell power systems would be relatively unimportant to potential users.

A successful fuel-cell bus would be extremely beneficial in demonstrating the value of fuel cells as vehicular power plants, and the city bus market of 5,000 vehicles per year could increase the demand for fuel cells without incurring the costs of full-scale mass production. In addition, fuel cells do not produce particulates or unpleasant exhaust odors common to diesel-powered vehicles, a definite asset for urban operations, and they would be immune to diesel fuel supply problems. For all these reasons, the city bus was deemed particularly amenable to fuel-cell power.

☐ *Highway Buses and Trucks.* Powering highway buses and heavy trucks appears to be another excellent application of fuel cells. Again, performance projections are limited. Utility data are helpful but sometimes of questionable value. For example, utilities project a 40,000-hour operational lifetime for their stationary fuel cells; the typical lifetime of a diesel-powered highway bus is only about 20,000 hours (about 1 million miles), but vehicular fuel cells would be subjected to stresses not present in the utility application.

What would a fuel-cell-powered highway bus or truck require for power — and what would it cost? To cruise at 55 miles per hour, nearly fully loaded at 36,500 pounds, a bus or truck would require a 119-kilowatt fuel cell plus 34 kilowatt-hours of storage battery capacity for climbing hills (based on the power needed to climb a 2-percent, 20-mile grade at 55 miles per hour). Such a system (including the reformer) would require 85 cubic feet of volume; about 516 cubic feet are presently available if required on a typical Greyhound bus. Thus, a bus (or large truck) can easily accommodate such a system. The price of the bus would be about $145,000 in 1978 dollars, compared with $120,000 for a conventional diesel vehicle. But fuel-cost savings would be impressive. At 1978 diesel fuel prices, a propane-powered fuel-cell bus would cost an additional 0.47¢ per mile to operate. Based on increased diesel fuel prices since the "applications scenario," by 1990 a fuel-cell bus running on reformed methanol would produce significant savings in fuel costs. (Even at 1978 diesel fuel prices, the use of methanol would have *saved* 1.56¢ per mile in fuel costs for a total of $15,600 over a million-mile lifetime. Additional savings from reduced maintenance costs (estimated from utility data) could total between $13,400 and $33,400.

☐ *Delivery Vans.* A large delivery step-van powered by conventional storage batteries with fuel cells for on-board recharging is the most promising configuration for stop-and-go service. Power requirements, calculated from typical United Parcel Service drive cycles supplied by Ford Motor Co., indicate that a delivery van of 8,300 pounds gross weight would require only a 7-kilowatt fuel cell in parallel with storage batteries having 9.6 kilowatt-hours of capacity. Without the fuel cell, the van would require batteries with 48 kilowatt-hours of capacity



Fuel-cell-powered golf cart developed at Los Alamos Scientific Laboratory. Air and tanks of hydrogen currently feed the fuel cell, which is enclosed by insulation. The addition of a reformer would permit the use of a methanol-water fuel mixture. (*Photo: Los Alamos Scientific Laboratory*)

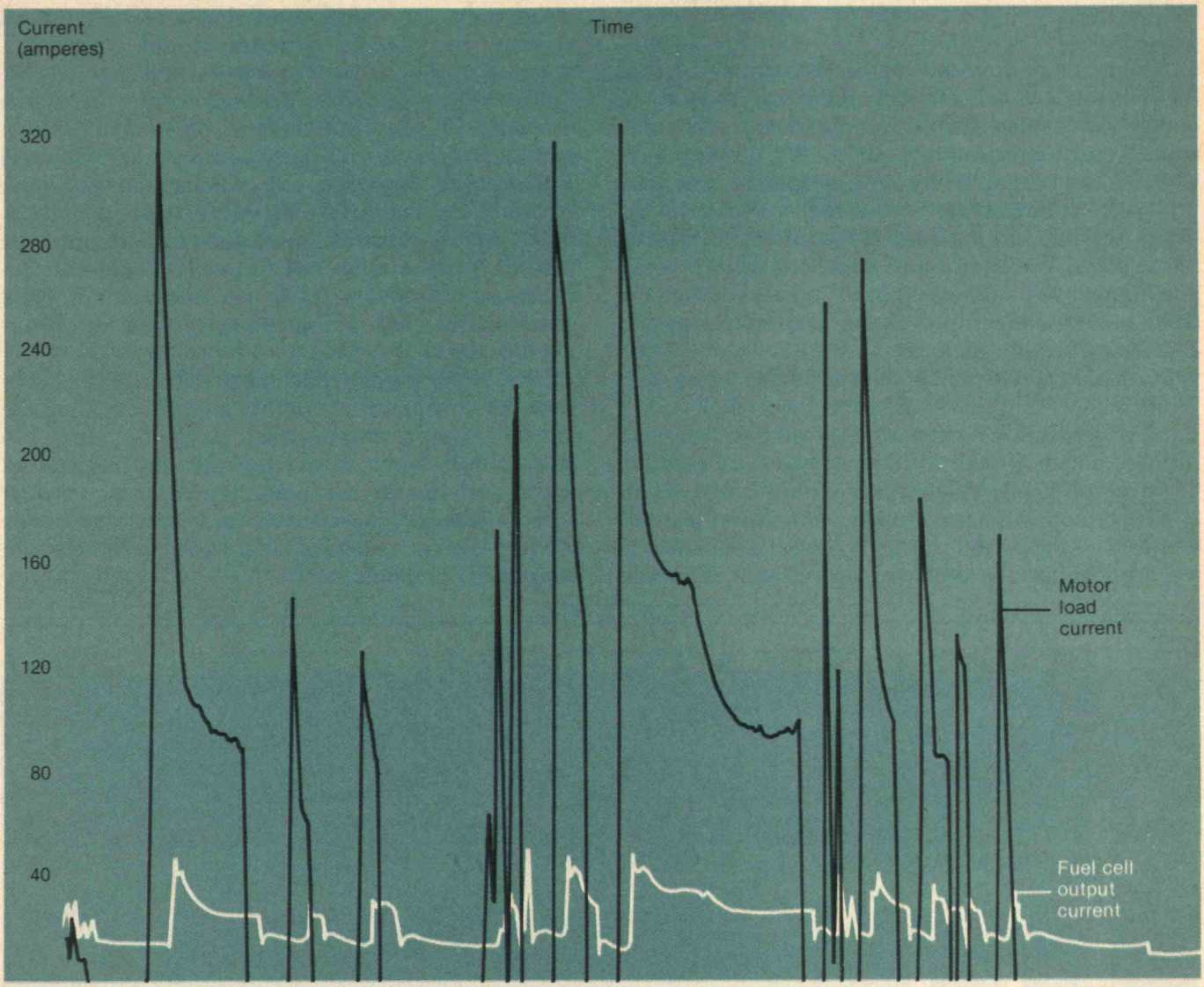
Fuel-Cell Golf Cart

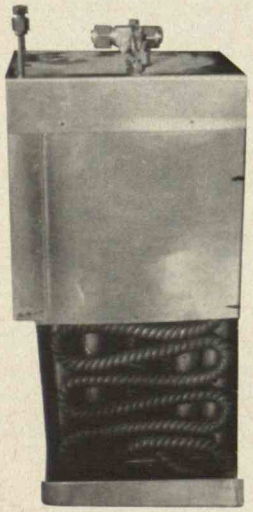
The Los Alamos Scientific Laboratory Electronics Division has designed and built a golf cart powered with fuel cells and storage batteries to evaluate the performance of this hybrid electric propulsion system. To date, the cart has operated smoothly and reliably. Tests have verified performance expectations. Upcoming tests will include more detailed evaluations under prolonged stress conditions to evaluate the effects of prolonged high-current operation.

Built by Energy Research Corp., the phosphoric-acid-electrolyte fuel cell used in the golf cart can generate approximately two kilowatts of electrical power. It has been fueled with hydrogen and oxygen stored in aluminum scuba tanks, but the addition of a methanol reformer is imminent.

Four 12-volt stoarge batteries, with a total capacity of 4 kilowatt-hours at a 20-hour discharge rate, allow separate testing in an all-battery mode. The fuel cell and batteries are coupled through a diode, which permits the fuel cell to charge the battery but prevents the battery from discharging through the fuel cell. The electrical load is shared automatically between fuel cell and batteries: when the motor load exceeds about 40 amperes, the battery dominates as the source of electricity; for lesser loads, the fuel cell dominates. At peak transients (as during rapid acceleration) when the load current to the motor may approach 300 amperes, the batteries provide about 250 amperes of current and the fuel cell makes up the difference of 50 amperes.

A conventional controller is used to vary motor speed. The hydrogen flow to the fuel cell is regulated by a control system that senses fuel-cell current (the amount of hydrogen required by the fuel cell is directly proportional to its output current) and generates a control signal that appropriately regulates hydrogen flow.— *J.B.M.* □





Left:
Cutaway of a reformer of the type planned for the fuel-cell-powered golf cart; it will produce hydrogen from methanol, eliminating the necessity for separate supplies of cryogenic or tanked hydrogen aboard the vehicle. The reformer consists of a series of tubes containing small pellets coated with a zinc-copper catalyst; when the methanol-water fuel mixture is circulated through the tubing at 200°C, the catalyst converts it into hydrogen (supplied to the fuel cell as needed) and carbon dioxide (a waste product). (*Photo: Los Alamos Scientific Laboratory*)

Above:
How fuel cell and batteries work together to provide electric energy for propulsion of a fuel-cell-powered golf cart during a typical drive cycle test at Los Alamos Scientific Laboratory. When the current demand of the propulsion motor exceeds the output of the fuel cell, the batteries supply the deficit; when motor load is low, surplus electricity from the fuel cell is used to recharge the storage batteries. (*Data: J. Byron McCormick*)

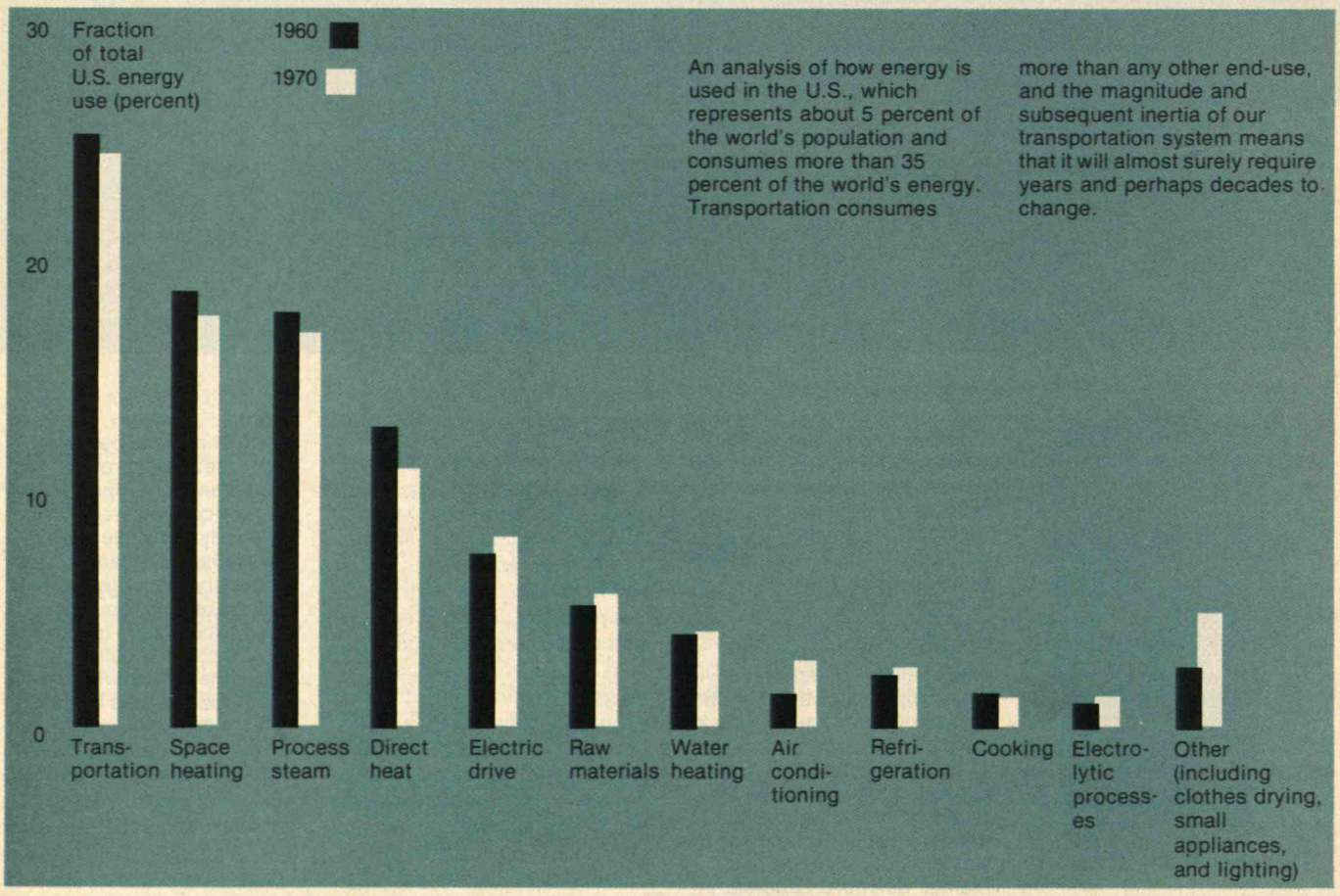
weighing over 4,000 pounds to complete a similar route.

Maintenance costs for a storage-battery-powered van with a fuel cell for recharging are likely to be much lower than for conventional vans. Maintenance cost reductions of 30 to 40 percent have already been reported by several operators of electric (i.e., storage-battery-powered) vehicles in delivery service, and the batteries incurred the bulk of those costs. The addition of a fuel cell would reduce the number of batteries required and also maintain a voltage across them, preventing deep discharge and increasing battery lifetime.

☐ *Consumer Vehicles.* A vehicle similar in size to a Volkswagen Rabbit should perform well when equipped with a 15-kilowatt fuel cell and lead-acid storage batteries with 4 kilowatt-hours of capacity to meet peak power needs. It would cruise at 55 miles per hour on battery power only for at least 15 minutes — the period presently required for starting up a phosphoric-acid-electrolyte fuel cell. It would weigh only 622 pounds more than a diesel-powered version; the storage batteries would weigh 281 pounds.

The sticker price? Surprisingly competitive at a projected $7,240 (1978 dollars), based on 1978 cost and markup data from Ford Motor Co., DOT, and Volkswagen, assuming automakers pay $200 per kilowatt for the fuel-cell/reformer system as projected by the Electric Power Research Institute (at present, small numbers of fuel cells would cost between $1,000 and $20,000 per kilowatt). A 1978 gasoline-powered Rabbit was priced at about $4,400.

The participants concluded that the fuel-cell-powered consumer car could eventually supplant the internal-combustion-engined passenger car. No clear-cut economic advantage based on fuel savings was found, but the low noise, nonpolluting exhaust gases, minimal maintenance, and reliability of the fuel-cell electric car were cited as likely to help win consumer acceptance.



An analysis of how energy is used in the U.S., which represents about 5 percent of the world's population and consumes more than 35 percent of the world's energy. Transportation consumes more than any other end-use, and the magnitude and subsequent inertia of our transportation system means that it will almost surely require years and perhaps decades to change.

The quiet and nonpolluting performance, minimal maintenance requirements, and high reliability of fuel-cell-powered passenger cars may help win consumer acceptance.

Down the Economic Turnpike

Since the "applications scenario" was completed, the retail prices of gasoline and diesel fuel have more than doubled (the 1978 scenario assumed gasoline would retail at $.65 per gallon in 1990). Today's high fuel prices make fuel cells look much better: when the price of gasoline is slightly over $1.50 per gallon, a vehicle powered by a fuel cell costing $200 per kilowatt will repay the extra cost of the fuel propulsion system on fuel savings alone over a 120,000-mile service life.

But it hasn't begun to happen yet. Powering vehicles with fuel cells seems technically feasible, but experience is scanty, and the infrastructures and capital commitments of the automotive and petroleum industries limit the speed with which fundamental vehicle design changes can be implemented. Thorough testing of fuel-cell propulsion systems during continued physical shock, vibration, repeated on-off operation, and other common vehicular stresses is needed to establish a performance record and provide direction for further development (*see "Fuel-Cell Golf Cart," p. 60*).

One fundamental design change, particularly likely for a consumer vehicle, is the reduction or elimination of platinum in the catalysts in fuel cells because of the unexpected surge in the price of this precious metal. The current price paid by large industrial users is approximately $400 per troy ounce — about $105 per kilowatt based on present performance levels of about 90 watts of output per square foot of fuel-cell electrode (each square foot of electrode contains 0.75 gram of platinum catalyst). The cost problem can be solved in two ways: by improving fuel-cell power density (the amount of power produced per unit area of electrode), thereby making it possible to use less platinum per kilowatt produced; or by finding cheaper materials to substitute for platinum. Technical efforts in both these areas have already shown promise but must be vigorously pursued if they are to lead to the de-

Economic viability of fuel cells is difficult to prove. Significant on-the-road experience has not yet been accumulated . . .

velopment of commercially available fuel cells for electric vehicular propulsion within a reasonable time.

☐ New acid electrolytes can boost the power density of fuel cells, though they have yet to be proven in long-term service. For example, replacement of phosphoric acid with fluorinated sulfonic acids has doubled the performance of small experimental cells. These so-called "superacids" increase the reactivity in fuel cells and aren't absorbed on the platinum catalysts, as is phosphoric acid. Further work could quite possibly permit savings in weight and volume over present-day phosphoric acid systems. Investigations since the "applications scenario" projected that the performance of a fuel-cell/battery X-car hybrid would improve dramatically with the use of the advanced electrolyte tetrafluorethanedisulphonic acid (TEDSA). The weight of the resulting fuel cell would be substantially less and fuel economy considerably better.

☐ Alternative catalysts for both the anode and the cathode in phosphoric-acid fuel cells are being studied. Tungsten carbide and doped tungsten carbide anodes show promise for achieving performance equivalent to platinum; organometallic cathodes made of porphyrins or tetraazannulenes have shown performance equivalent to cathodes made of platinum. Indications are that these materials could be sufficiently stable for long-term use in fuel cells, although substantial engineering effort is still required.

The ultimate payoff for the successful development of fuel-cell-powered vehicles would be the high-efficiency utilization of clean, plentiful, nonpetroleum fuel sources. Our legacy to future generations could be a cleaner, less energy-starved world.

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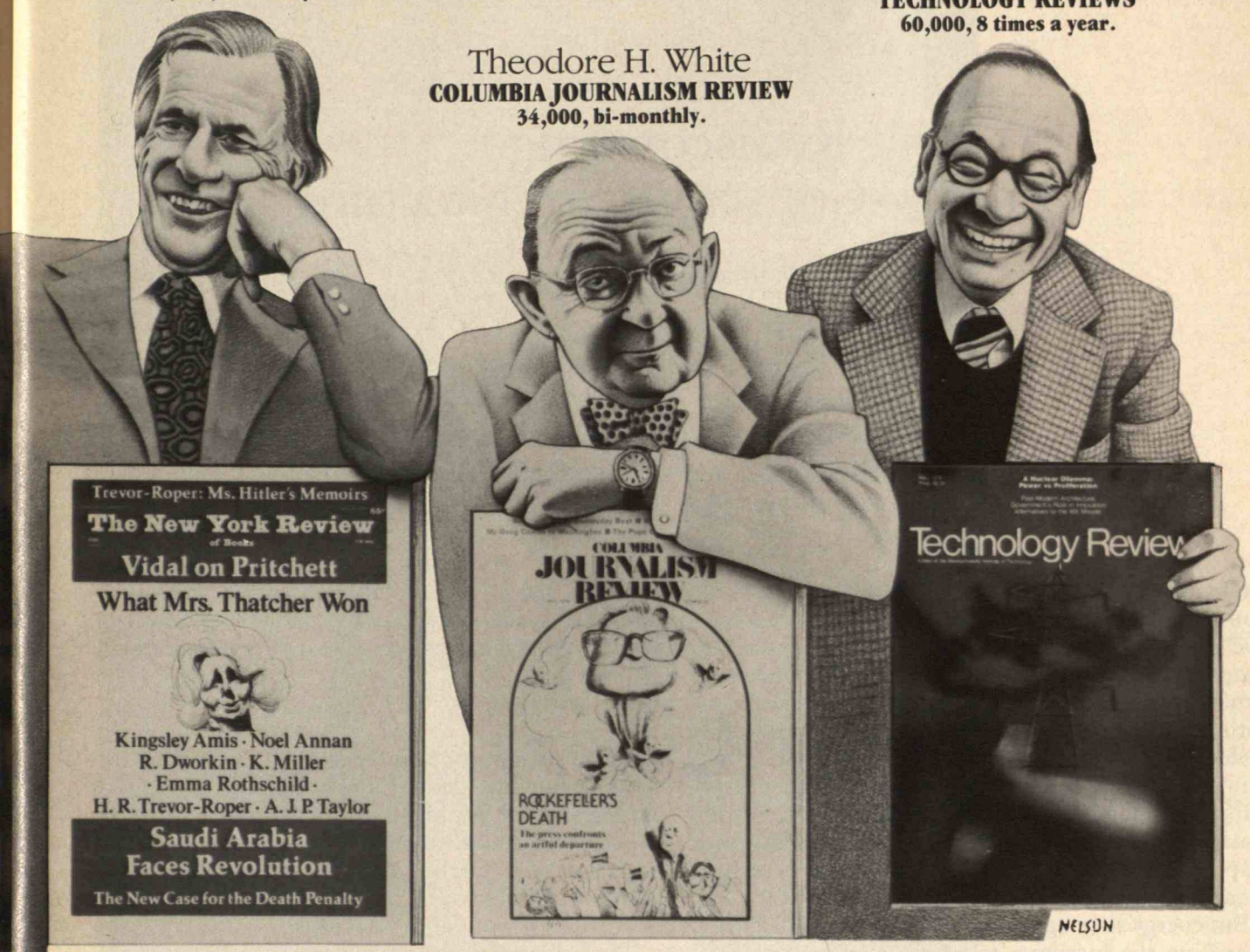

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Rediscovering Energy-Conscious Architecture

by Selma A. Newburgh

Passive concepts, wherein the form of the building itself provides heating or cooling, were once traditional throughout the world. Energy conservation is inspiring their rediscovery by modern architects.

Interaction between building form and local conditions is not an original idea. What we now call passive system design has a long and rich history, in fact, reflected in traditional building forms and construction methods. Only in the twentieth century — with increased use of energy, the evolution of the sealed interior environment, and sophisticated communications systems — has it been possible to transplant materials and forms to all corners of the world. This process has often led to anonymity and inappropriateness of design in addition to excessive energy consumption.

But energy shortages may be a blessing in disguise, providing the incentive to create a more rational, relevant, and socially responsible architecture.

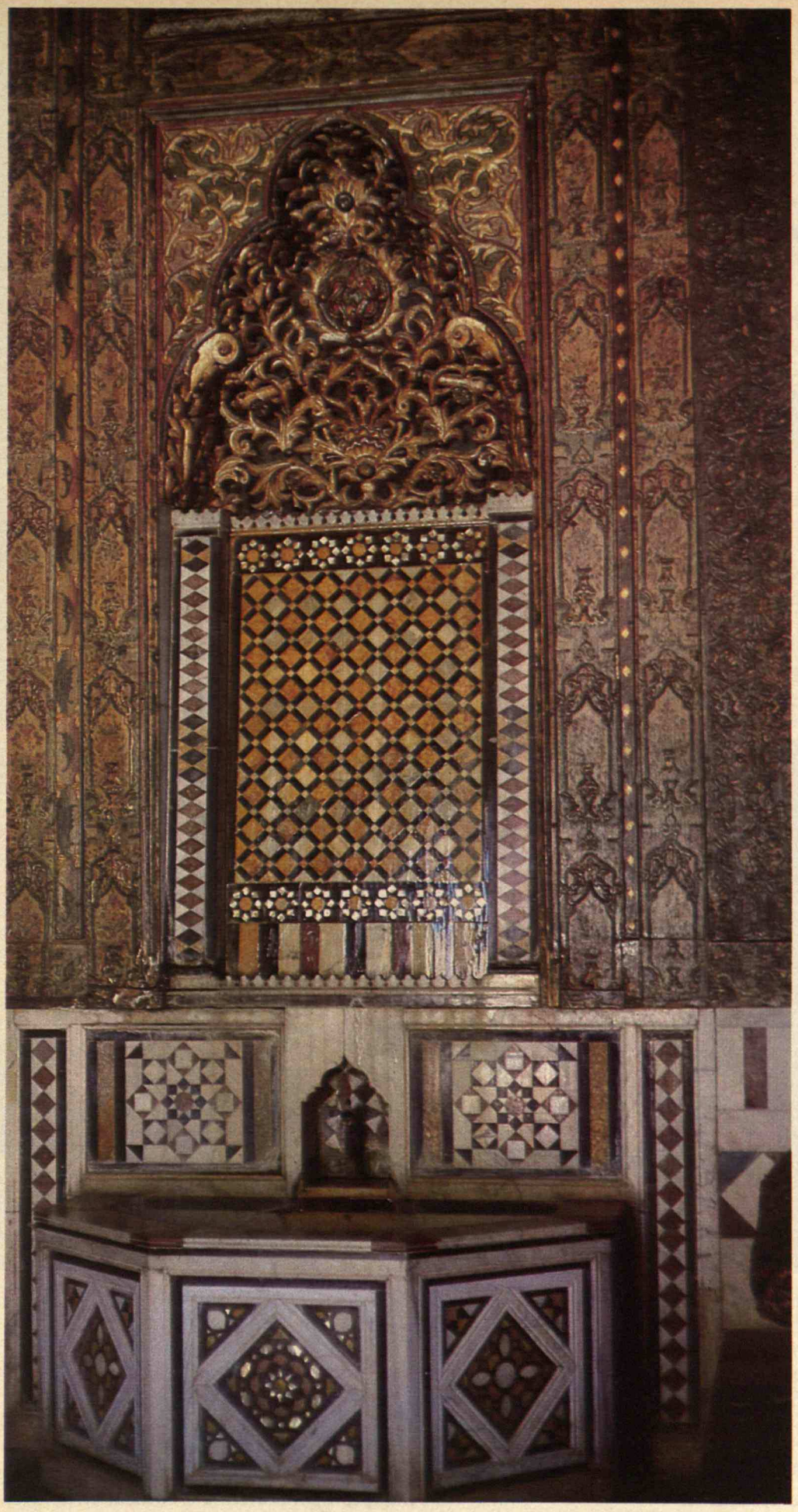
Energy conservation is measured in terms of energy *not* used in operating and maintaining a given building, as determined by comparison with similar buildings constructed in the early 1970s (pre-"energy crisis"). By convention, energy-conserving designs are distinguished as either active or passive. "Active" denotes improved mechanical/electrical and energy-management systems that reduce the energy consumed by building operations and maintenance. Sometimes they also include an alternative power source — solar, wind, biomass, or geothermal, for example — to supplement the conventional power source. "Passive," on the other hand, implies building forms that generate conditions of comfort and satisfy operational needs without resorting to mechanical means. These designs take advantage of natural physical properties — absorption, radiation, reflectance, conductance, and convection — to collect, store, and transmit heat from the sun and to provide ventilation. Active systems, in a word, are primarily engineering solutions, while passive systems are primarily architectural.

It's a Tradition

Passive concepts have long been utilized in traditional building designs and construction methods throughout the world. Local influences produce contrasting building forms, yet because dependence on the physical properties of materials and geophysical events is a constant thread, many similarities in architectural forms can be observed.

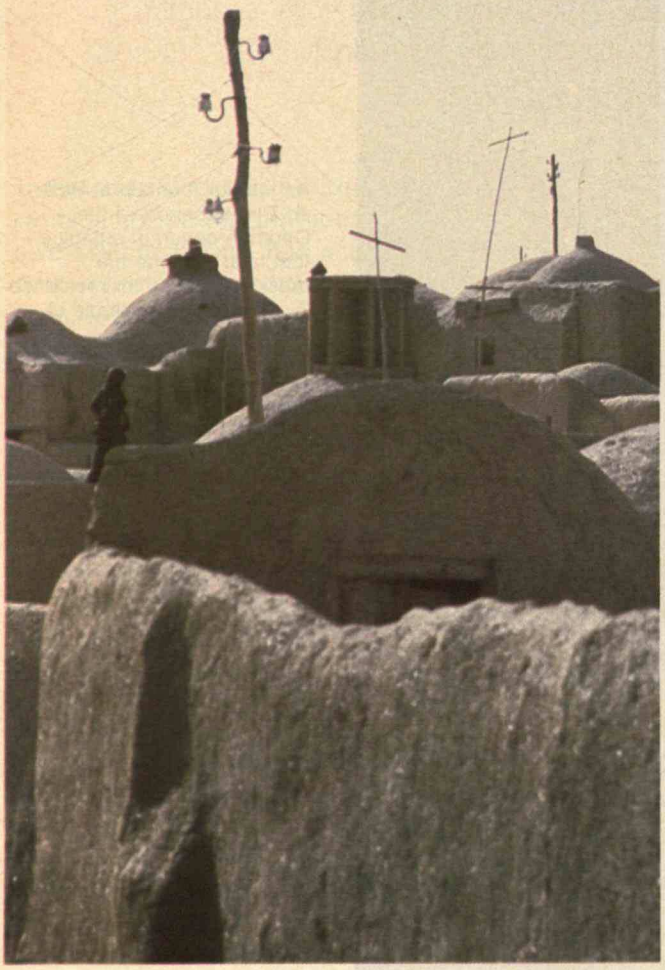
The Eskimo house — the igloo — is a classic example of a building type that capitalizes on available resources. Ice blocks are used as masonry units to build a stable spherical structure that minimizes exposed skin area. Insulation is provided by snow piled against the exterior of the structure, while joints between the ice blocks are sealed by melting caused by the warm interiors. A single, barrel-vaulted entrance facing away from prevailing winds is provided. The igloo thus combines principles of compact volume and insulation to minimize heat loss, and orientation away from winds to reduce infiltration of cold air and heat loss by convection.

Underground structures in southern Turkey and Iraq demonstrate effective insulation for cooling as well as heating. They also use available resources for construction, in this case earth, which is an excellent insulator with a high capacity to retain heat. This is especially useful in hot and arid climates which have great differentials between day and night temperatures.



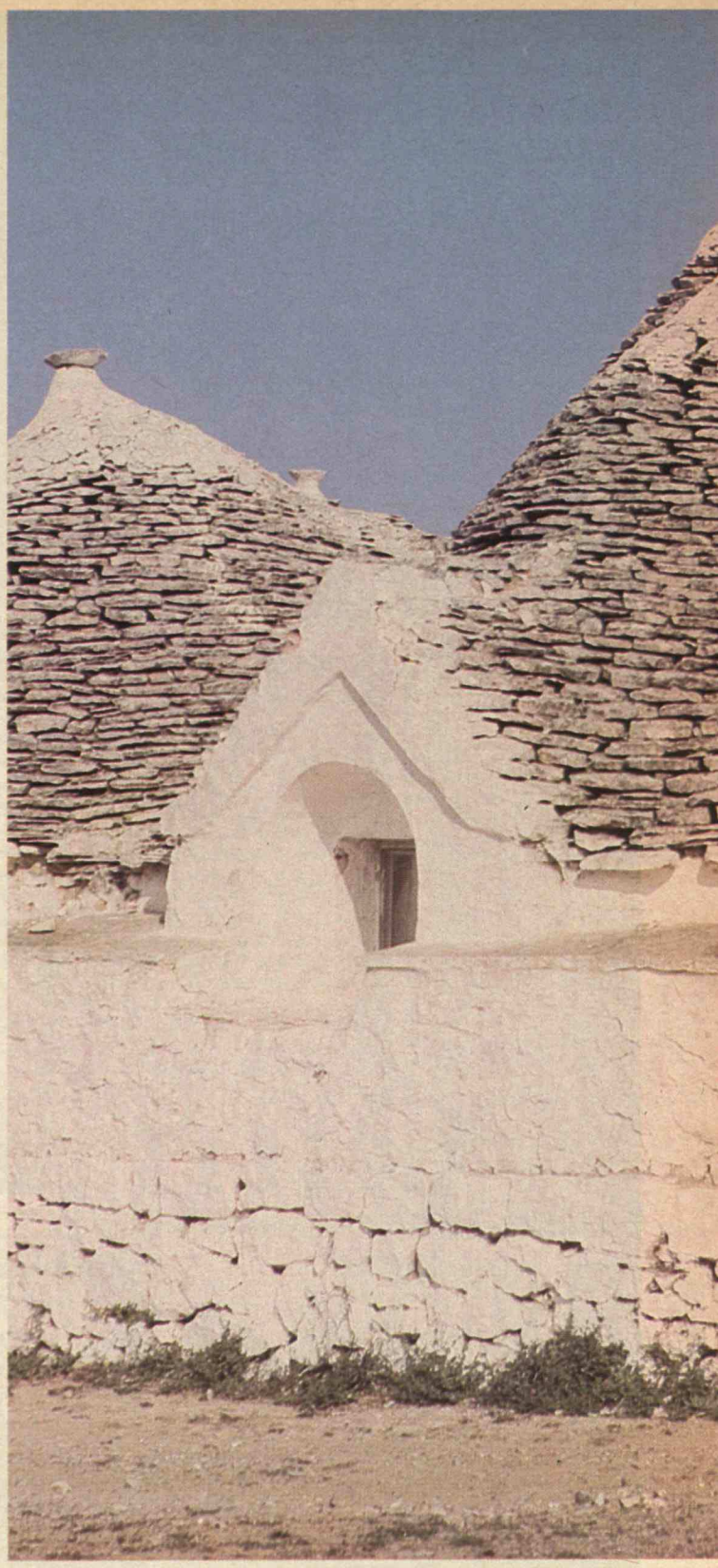
An interior fountain at Beit-ed-Din, Lebanon — the Ottoman governor's palace that later became the president's summer residence — provides an example of comfort control that is practical, energy-efficient, and beautiful. As water runs across the mosaic tile, it evaporates to humidify, and thereby cool, an otherwise dry climate. A positive side effect is the soothing sound of the gently rippling water.

Selma Newburgh



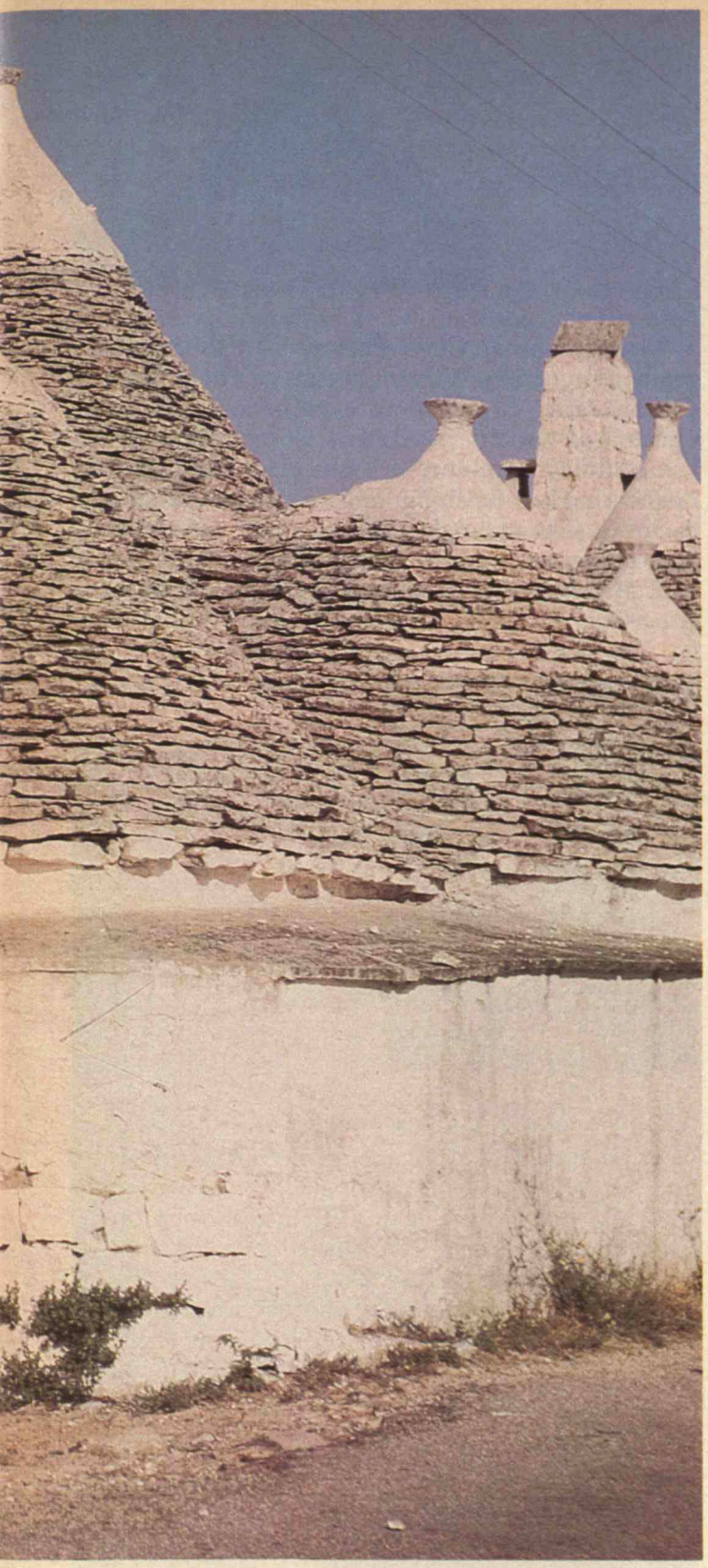
Tom Huf

Adobe and mud-brick structures in Indian settlements of the American Southwest and the Arabian peninsula also use the thermal properties of earth to keep the interiors cool during the day and warm at night and in winter. The thick earthen walls slowly absorb and retain the sun's heat during the day, thus insulating the interior. At night, as the outside air cools off, heat retained in the structure is released by radiation, heating the space around it.

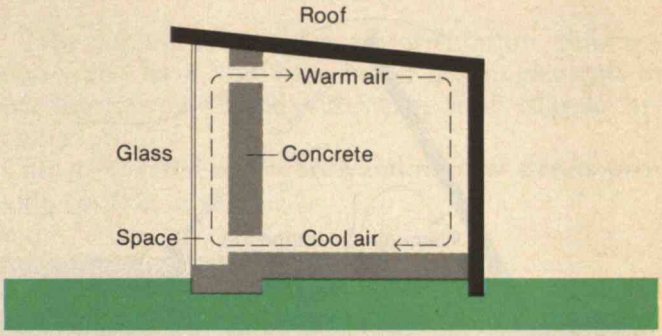


Anne Hartmere

The Trulli houses in Southern Italy present an interesting variation on building form generated by concepts of thermal mass heat storage and compact volume. The climate-control problem here also requires insulation from the hot outdoors during the day and for the retention of indoor heat at night. Stone, with thermal properties akin to earth, is the predominant building material. The architectural form that has been generated is a conical structure,



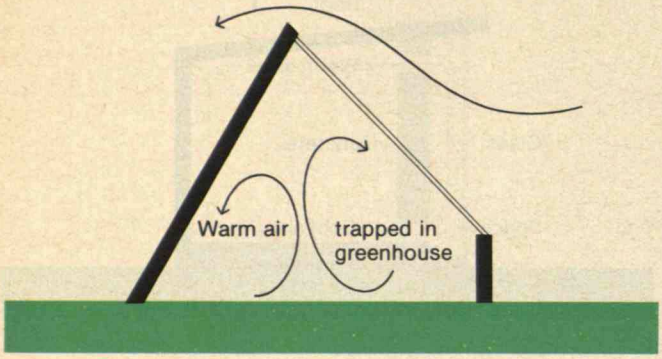
built without mortar, of progressively smaller stone rings. The construction technique is based on the "corbelled arch," which gains stability from the weight of materials piled above and behind each cantilevered unit. The heavy mass generated by this technique has great heat absorption and storage capacity, and the conical volume is another effective shape for reducing the exterior surface area through which heat may be gained or lost.



The Trombé wall (named for French engineer Felix Trombé) is a passive heating system often used in modern solar houses and is based on the same principle of thermal mass storage. Trombe walls form a sandwich consisting of a heat-collecting glass surface on the exterior, an air space in the middle, and a heat-absorbing wall on the interior. The whole assembly is oriented to the south for maximum exposure to the sun. During the day, heat collected by the glass surface is transmitted to the wall behind by radiation. Warm air rises in the air space (a chimney effect), drawing in cool air from the room beyond the wall, and this continuous air circulation warms the space. When equipped with movable insulating panels and an exterior venting system, Trombe walls may also be used as heat insulators during the day (in hot weather) and as a radiant heat source at night. Various heat storage or heat sink schemes — such as thermal tiles, a rock bed below the floor, and water-filled barrels — are also based on the same concept.

B. Alexander Hamilton

Traditional greenhouses are building types generated by the need to capture as much light as possible. This has resulted in north-south orientation and a structural system allowing completely glazed roofs. The construction system developed for large-scale glass houses in England in the nineteenth century became the model for early cast-iron construction, which then evolved into the steel skeleton structures of the twentieth century.



Modern solar greenhouses combine passive system design concepts of orientation to the sun, radiation, convection, and heat absorption. The sun's energy passes through glass and the heat in the interior rises toward the ceiling by convection. The warm air, on contact with the cooler surface of the glazing, loses heat and drops down, and continuous air circulation is generated. The solar greenhouse is one of the most effective means for generating heat passively — for spaces occupied by people as well as plants. Combined with a heat-storage and induced-air circulation system, the greenhouse effect has the potential for becoming the sole source of heat for many types of buildings.

In hot and humid areas, the need for shading and ventilation, rather than insulation and heat retention, becomes most critical.

Selma Newburgh

The Philippine nippa hut is an effective building form generated by the need for natural ventilation. Built entirely of the trunk and fronds of the nippa palm, the hut traditionally rests on high ground. It is open to the exterior on all sides — even the floor is raised above the ground — and is topped by a large pyramidal roof to provide shade. The interior space is open and rises to vents placed at the top of the pyramid. Warmer air entering from the floor and sides rises by convection toward the openings at the top, generating continuous air movement.

The Rosenthal Glass Factory in Amberg, Germany designed by Walter Gropius at The Architects Collaborative is a modern expression of the same concept of natural ventilation. Completed in 1970, the building combines a main glass-blowing hall, space for glass finishing, and receiving and storage facilities. The main glass-blowing hall was designed to compensate for the intense temperatures (1,300 to 2,400 degrees F) generated by the glass-blowing process.

Louis Reems

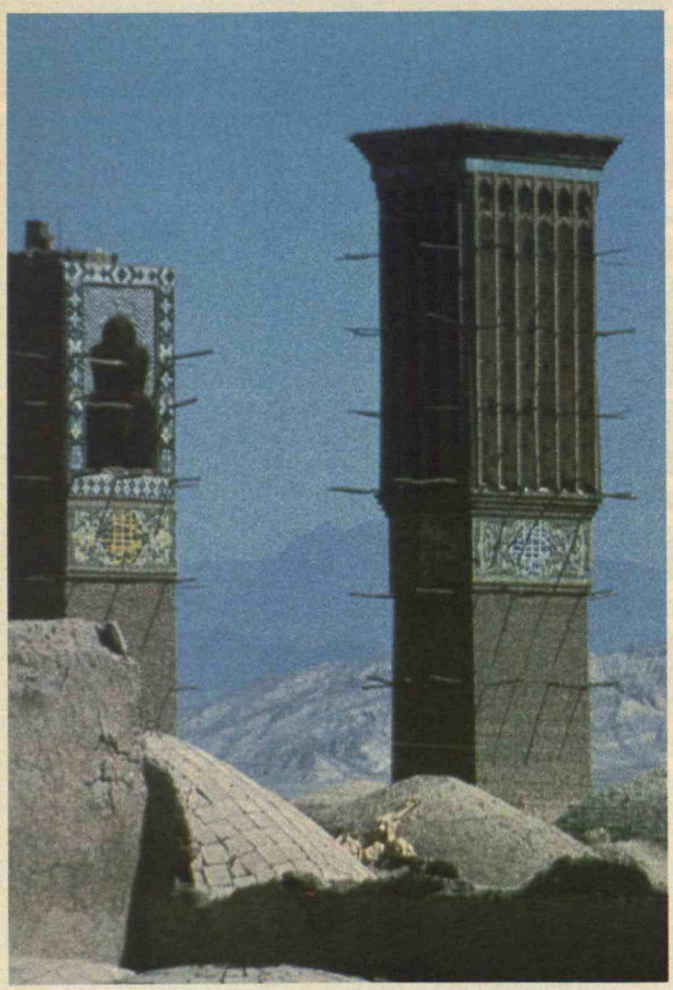
As in the nippa hut, the building form is designed to draw in cool air from open courtyards at the sides and to exhaust hot air through the louvers within the roof walls and the slot along the ridge of the roof. The louvers and the slotted ridge also admit daylight into the work space.

Response to the wind is another form-giver. In cold climates, building forms are located in sheltered spots and oriented away from prevailing cold winds.

Selma Newburgh

The traditional New England salt box orients its long sloping roof toward the northern winds and opens up to the warm south. The roof thus not only shelters the house by deflecting the wind but also reduces infiltration.

In hot climates, however, buildings are designed to be open to the wind and to encourage penetration of prevailing breezes for ventilation and cooling. In the gulf states in the Arabian peninsula — in Iraq, Iran, and parts of India, for instance — wind towers are distinctive architectural forms. Wind scoops face the prevailing wind and deflect the air into a channel within the walls of the building. The conduits are located within interior walls, free from the effect of solar radiation. They pass through the rooms and open to the courtyard, pushing the warm air forward and upward. In locales of highly variable wind direction, wind scoops are designed like sails on pivots, reminiscent of a wind vane.



Tom Huf

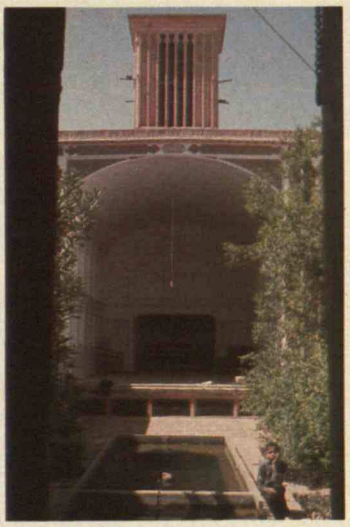
Wind towers face all four directions and provide individual funnels for intake and exhaust air. The windward face catches and directs the air inward and downward, while the suction created at the leeward side draws the warm air out from the interior.

The cooling effects of north orientation, shading, and water have long been major design elements in Mediterranean, Middle Eastern, and Islamic architecture.

Canvas-covered courtyards and narrow streets provide cooling at midday.

Tony Yamada

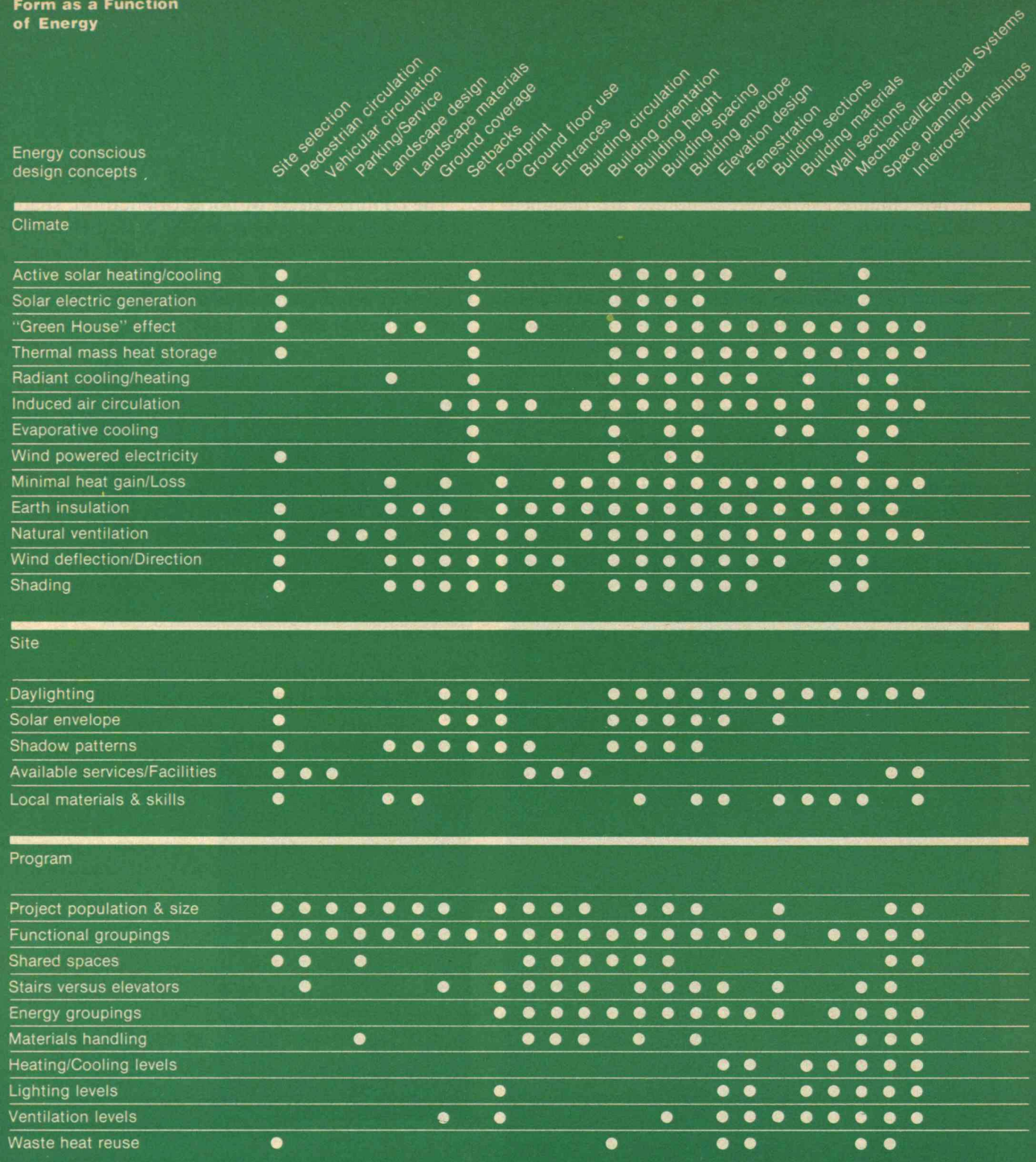
Living spaces traditionally face north and open onto courtyards cooled by a pool or fountain.



Tom Huf

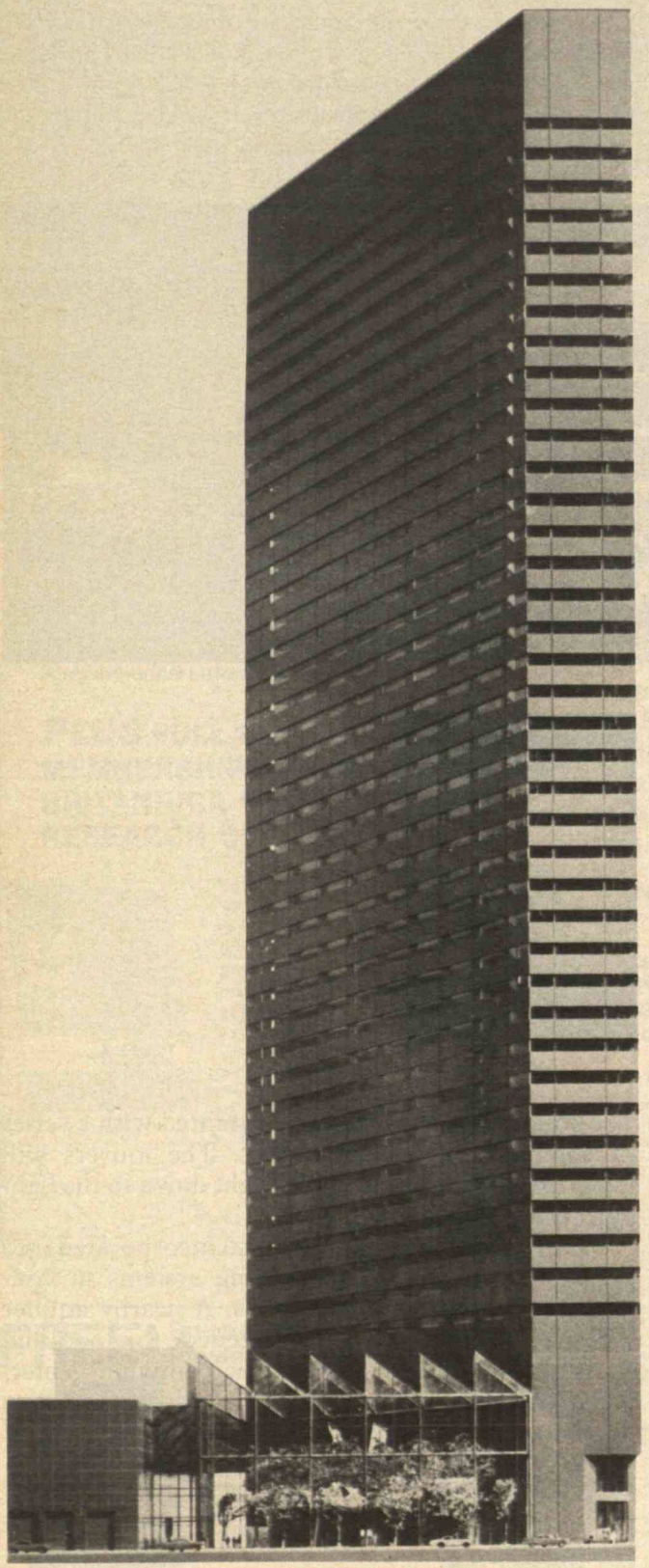
In more elaborate houses, interior fountains provide relief (*see page 69*). In India, cooling is accomplished by hanging moist fabrics across openings to filter incoming air. In Turkey, which has a colder climate, traditional houses have separate summer and winter living rooms. The summer salon faces north and has taller ceilings, whereas the winter salon faces south and has a lower ceiling. In central Anatolia, separate summer and winter quarters are built on the north-facing and south-facing sides of residential compounds, and families "migrate" from one to the other with the seasons.

Form as a Function of Energy



The decision to build is itself energy-related. Questions to be raised include whether a new facility is really needed — recycling and rehabilitation of existing buildings may be satisfactory. If a new building is needed, formulating energy-conscious design solutions requires an extensive analysis of these variables at the *start* of the design process. During this phase, energy needs and opportunities for reducing dependence on energy-intensive systems can be identified and evaluated. Correlations between basic architectural design factors and energy-conservation concepts become the primary determinants of architectural form.

Passive architectural decisions affect, in turn, the design parameters of the active mechanical/electrical systems. Energy-conscious factors to be considered here include options for alternative energy sources and for sophisticated controls and energy-management devices to optimally deliver needed levels of heating, cooling, and lighting.



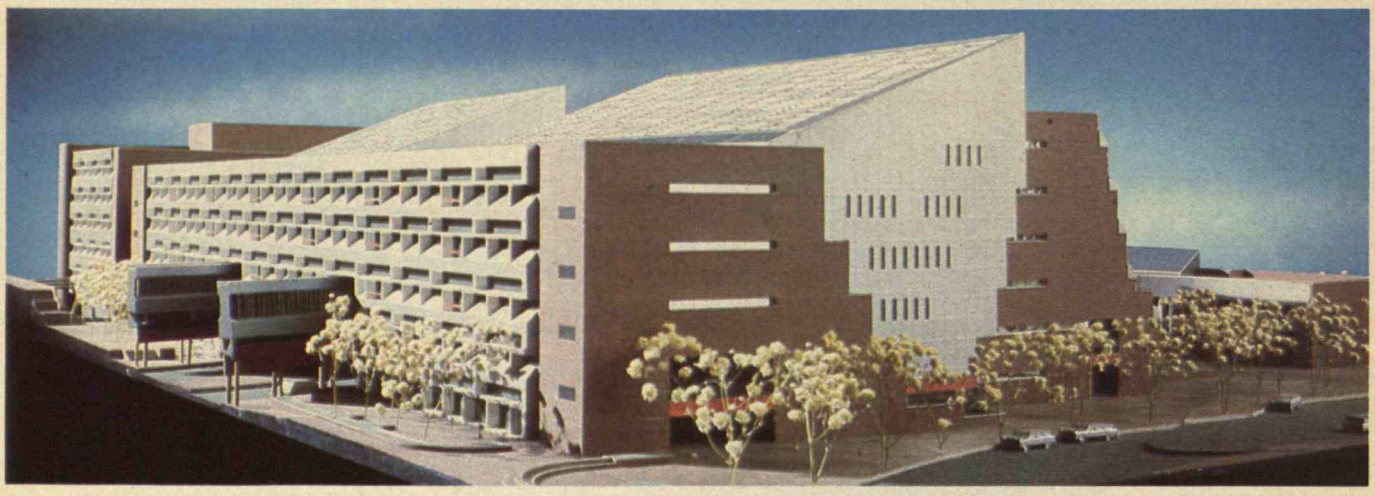
Taking Design Onward and Upward

Although both active and passive design concepts can have profound influence on architectural decisions, energy-conserving buildings of the last ten years or so were mainly designed according to active system requirements. As the state of the art develops, however, passive systems are being used more extensively. And this experience indicates not only that more energy may be saved with *combinations* of active and passive systems, but also that passive concepts influence a wider array of design decisions.

IBM's new office building, under construction on Madison Avenue, incorporates the latest energy-efficient mechanical/electrical building systems. Primarily using active systems, this design is projected to reduce energy consumption by 50 percent. The 43-story building is five-sided and features a glass-enclosed public plaza in a 4-story "greenhouse." Basic energy goals of the design are to minimize the load on the heating, ventilating, and air-conditioning system, to use the least amount of energy in satisfying the need for climate control, and to allow flexibility in the system to accommodate changing conditions and new developments. The first goal requires that heat gained or lost through the exterior skin of the building be minimized. Consequently, window area is kept to 35 percent of the total surface, glass is tinted and double glazed, and heavy insulation is incorporated. An innovative response to the need for saving energy is an operable vent below every other window. This device is an intended fail-safe in case of complete or partial power failure, as well as an option for improving individual comfort.

The building's energy use will be monitored by a highly sophisticated computerized system with a network of over 1,000 microprocessors and at key locations. These "smart thermostats" will control temperature and lighting levels throughout the building. The system can also detect and identify problems that may cause energy waste. Other energy-saving measures in the design include reclamation of waste heat for use in the interior zones and the street-level atrium, the use of night air to flush the system and precool the building, and illumination at the perimeter zones with natural lighting. *(Architect: Edward Larrabee Barnes)*

The TVA office complex in downtown Chattanooga — with approximately 1.2 million square feet of office space, including the central computer serving the entire TVA system — is based on a combination of active and passive concepts, but with an emphasis on the latter. Decisions were based on climate, alternative energy sources available in the region, and opportunities for conservation inherent in the building's functional needs. Designed in 1979 and scheduled for completion in mid-1983, the projected energy consumption will be 70 percent less than in comparable buildings.



Steve Rosenthal

The TVA design embraces two seemingly conflicting goals: to minimize heat gain (and therefore cooling load) in Chattanooga's warm and humid climate; and to minimize the need for artificial lighting. Reducing the heat gained through the building envelope implies a compact building with a low ratio of exterior surface to the volume it encloses. Minimizing artificial illumination, on the other hand, requires that the height, width, and spacing of the building be proportioned to permit full penetration of daylight into the interior. This implies a long and narrow building with a *high* surface-to-volume ratio.

This contradiction has been reconciled by joining pairs of north-south-oriented "slabs" on either side of a solar court to generate a relatively compact volume. The five- and six-story slabs are spaced on the basis of critical sun angles to allow light penetration and avoid casting shadows during a selected time span. The south wall is designed as a deeply articulated screen to shade out solar heat in summer yet admit solar heat in winter. The north wall is stepped out to receive as much diffuse light as possible. Reflectors are incorporated into the top four feet of the window walls to catch and transmit daylight deep into the interior by reflection along the ceiling. A similar set of reflectors is fitted along the terraced building form on either side of the solar court.

Steve Rosenthal

The solar court has a glazed roof fitted with a series of computer-controlled louvers. The louvers will track the sun and transmit daylight down to the light reflectors flanking the court.

Passive design concepts are also incorporated into the mechanical/electrical building systems in conjunction with the active systems. A nearby aquifer will supply chilled water needed for cooling. Waste-heat air (generated by the computer center) will be recycled to meet heating needs and assist in dehumidification. *(Design Team: TVA Architectural Design Branch, Candill Rowlett Scott, The Architects Collaborative, Van der Ryn/Calthorpe and Partners, Travis Price, William C. Lam, Syska & Hennessy, Inc.)*

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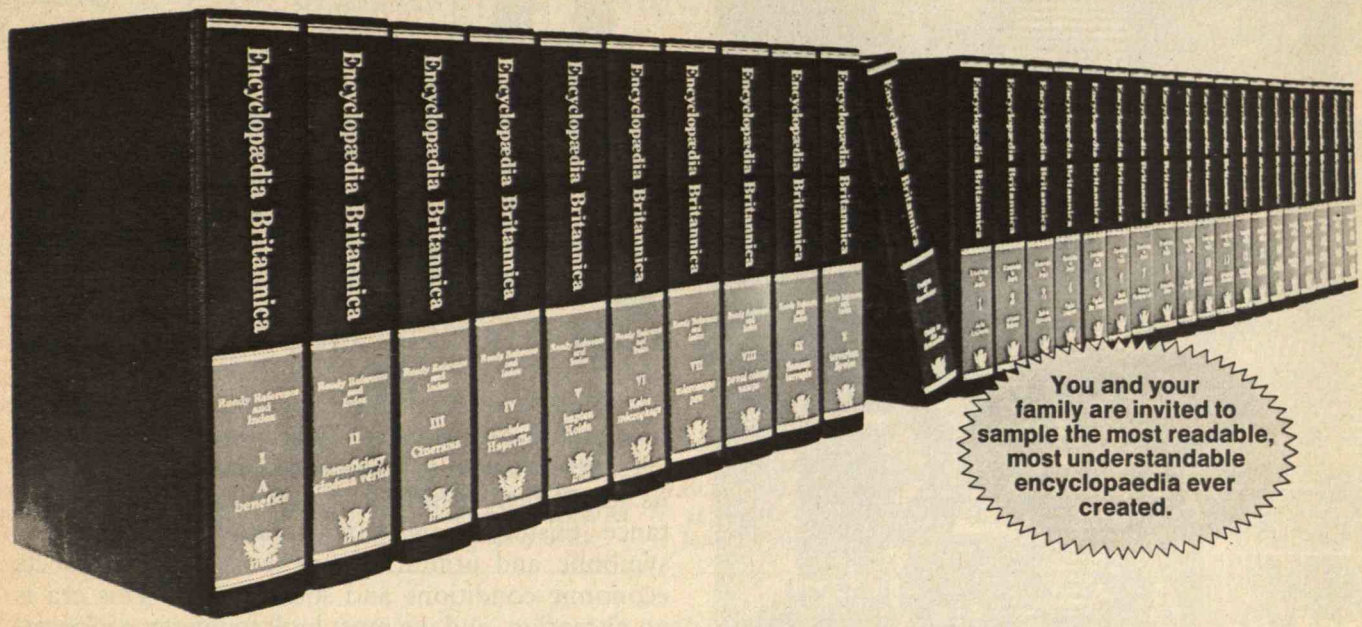

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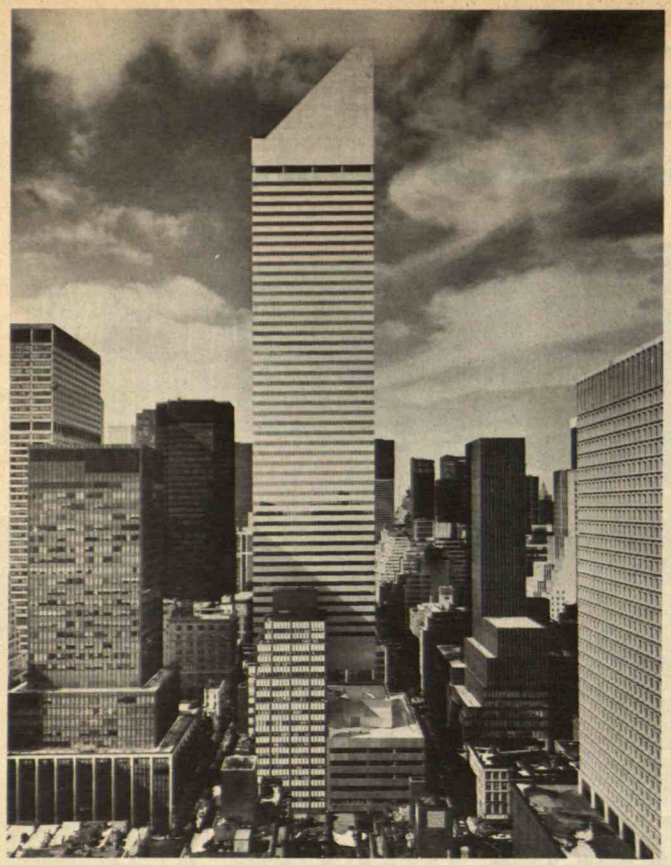


Norman McGrath

Citicorp Center comprises 2 million square feet (absorbing an entire city block in Manhattan) and rises to a height of 59 stories. Designed in 1974 for occupation in 1978, its energy consumption is 42 percent less than that of comparable structures erected in the early '70s. The building features an efficient heating, ventilating, and air-conditioning system using variable air volumes and dynamic controls. A central computer monitors energy consumption, adjusting heating and cooling levels and turning lights on or off according to a program for optimal energy use. Ambient light is reduced to 1.85 watts per square foot (the "conventional" figure is 4 watts per square foot); heat gained and lost through the exterior walls is kept to a minimum by a weather-tight skin; and waste heat produced by occupants, lights, and equipment is used to heat perimeter zones. Additional savings are achieved through double-deck elevators, reducing both the number of elevators needed and the power required to move them.

One of the most distinctive features of the buildings is its north-facing triangulated top. This top was originally designed for a solar cooling system, but the idea was not implemented. High costs and an excessively long payback period (95 years), as calculated during construction, were unacceptable.

The only passive influences on the building form are in the "fenestration" (number and distribution of windows) and the choice of materials. Citicorp's window area is 46 percent of the total surface area, instead of the mor conventional 60 percent, in order to reduce heat loss and gain. All windows are double-glazed, exterior layers of the glazing are reflected glass, anbd the exterior cladding material on the opaque portions of the skin is reflective aluminum. These materials were selected to reflect heat in the summer and help retain heat in the winter. *(Architects: Hugh Stubbins and Associates)*

Beyond the Horseless Carriage

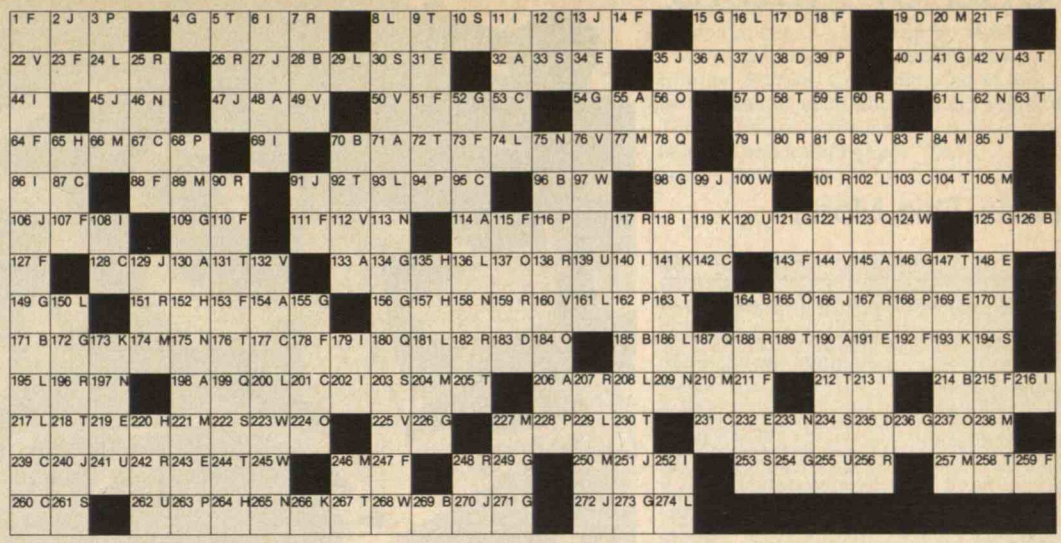
At a time when our entire society is evaluating attitudes and choices under permanent energy shortages, the chronic debate on architectural style and its ideological justification assumes greater importance. History shows that architecture, in both its symbolic and utilitarian functions, closely reflects economic conditions and social values. This era is no exception, and we must look to energy conservation as a stimulus for new directions in architecture.

Deliberate adoption of energy conservation as form-giver would reestablish the primacy of environmental factors in architectural design. The most effective designs would be those that closely reflect and capitalize on regional climate conditions. Use of local building materials and construction techniques would reestablish geographical differences, while climate-induced designs would provide consistency and harmony. Architectural forms generated by such an approach would transcend stylistic considerations and would be relatively independent of short-term fluctuations caused by fashion and whimsy. Moreover, since the new architecture would be based on permanent and observable phenomena, it would more likely be comprehensible and meaningful to its users and observers.

An analogy with the design of automobiles may be appropriate. Early models were horseless carriages, and they looked like horseless carriages. But except for such basics as four wheels and the need for passenger space, the forms of automobiles that have since evolved are far removed from their predecessors. By the same token, while early solar buildings may simply superimpose a collector on an ordinary frame house or glass box, we may look forward to new expressions in architectural forms as our knowledge and sophistication grow.

Selma A. Newburgh, a senior architect at The Architects Collaborative, Inc. (TAC) in Cambridge, Mass., received her master of architecture and master of city planning degrees from M.I.T. in 1964. Most recently, she was TAC's project manager for the TVA Chattanooga Office Complex project.

Glimpses of a Space Apart



Complete the word definitions; then enter the appropriate letters in the diagram to complete a quotation from a famous work of science fiction. The first letters of the defined words give the author and title from which the quotation is taken. Black squares in the diagram indicate the ends of words; if there is no black square at the right end of the diagram, the word continues on the next line. A solution to this Tech-Crostic will be in the next issue of the *Review*, when another of Mr. Forsberg's puzzles will also appear. Readers are invited to comment — and to suggest favorite texts for future puzzles.

A. One who divines with rods: a dowser

145 48 36 206 130 71 198 32 114
190 154 133 55

B. French composer, 1819-1880

96 70 171 214 269 164 185 28 126

C. Writing that reverses direction with each line

231 95 103 142 201 12 128 53 239
177 260 67 87

D. Hungarian physicist, 1848-1919, who worked in gravitation

235 38 19 57 17 183

E. A. Conan Doyle's "The _____ League"

59 169 34 219 243 191 31 232 148

F. Comedy of 1594 (5 words)

88 51 83 1 111 23 73 21 178
110 14 107 18 127 215 247 211 143
153 259 115 192 64

G. What Pooh-Bah attempted to give to "an otherwise bald and unconvincing narrative" (G&S, "Mikado") (2 words)

156 15 121 52 81 125 54 134 236
254 155 109 226 273 4 149 41 146
98 172 271 249

H. Second-millenium civilization in Asia Minor

152 264 65 220 135 157 122

I. Philosophical movement associated with Jean-Paul Sartre

252 118 6 140 179 44 108 11 202
69 216 86 213 79

J. Lustrous calcium/potassium silicate mineral

240 91 272 35 99 85 13 40 251
47 2 27 129 106 45 166 270

K. German negative

173 119 193 266 141

L. What the Dablet pays (Lewis Carroll, "Sylvie and Bruno") (3 words)

61 74 170 229 8 136 29 93 274
16 150 217 102 161 24 186 195 208
181 200

M. A British monarch (3 words)

77 238 257 204 84 174 250 20 210
221 66 105 89 246 227

N. Bavarian town on the Danube

209 46 265 62 233 113 158 175 197
75

O. Fitted inside one another

137 165 56 184 237 224

P. Incompletely cooked

228 116 94 3 263 162 39 68 168

Q. French town on the Muerthe

78 80 123 187 199

R. Very small (colloq. 4 words)

159 151 242 256 248 182 25 26 80
138 188 117 196 101 167 207 90 7
60

S. Indiana city on the Wabash

253 234 222 203 30 33 10 194 261

T. Record of cortical activity

163 205 58 63 267 72 9 131 104
43 147 189 230 212 244 258 218 92
5 176

U. Character in Verdi's "Aida"

255 144 241 262 139 120

V. Often-composed Latin hymn of Jacopone da Todi, 13th century (2 words)

50 76 225 37 112 160 22 42 82
49 132

W. Barren; exhausted; decadent

223 245 97 268 124 100

Trend of Affairs

Trends This Month

Energy 80

A solar furnace to vaporize limitations . . . Big solar photovoltaic systems shadowed by economics . . . Staging the end of gasoline queues.

Space Exploration 82

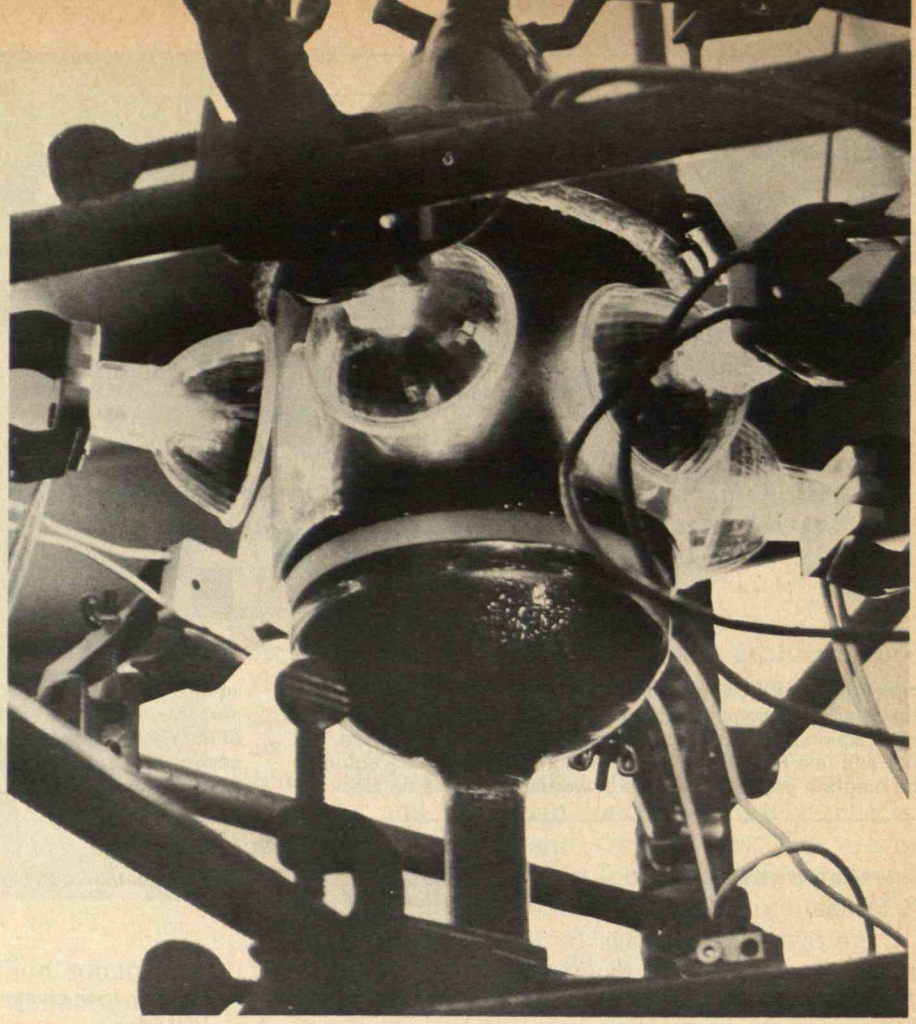
Venus: unique by heavenly standards . . . An uncertain appraisal of Saturn's moons.

Res Naturae 85

New life: private property . . . But the generic debate is alive and well . . . Indigenous plants — a wild card for survival.

Last Line 87

Media and scientists: a new connection is forged.



A small laboratory demonstration of SPHER (small particle heat exchange receiver), developed at Lawrence Berkeley Laboratory. Very fine carbon dust is blown in the top of the cauldron or heating chamber, which comprises the major bulk of the device. High-intensity light (in the laboratory version supplied by six electric lamps that substitute for concentrated sunlight) enters the chamber through sealed windows. The particles absorb the radiation, releasing the heat to the air confined within the chamber, and then vaporize, minimizing particulates in the hot exhaust flow. The device has a theoretical efficiency greater than 90 percent at output gas temperatures of 1000° C. (*Photo: Arlon J. Hunt*)

Energy

Dusting Off Solar Energy Conversion

The trouble with solar energy conversion is generic: sunlight is an extremely diffuse energy medium, and deriving useful power from it on a practical scale is a complex, costly business that can't compete with other energy sources.

That bleak outlook is based on the limits of performance of solar conversion devices that use unconcentrated sunlight for various tasks such as heating water or air and direct conversion into electricity. The major drawback of such converters is the fact that incident sunlight under the most favorable conditions contains much less than 1,000 watts of power per square meter at the surface of the earth.

Much greater potential exists in concentrated sunlight and a new way of harnessing this potential is being developed at Lawrence Berkeley Laboratory (LBL).

It's called SPHER (for small particle heat exchange receiver), a concept that was "picked up, studied, shelved, and picked up again several times" by physicist Arlon Hunt. The SPHER concept approaches the solar collection task on a microscopic scale, with a theoretical efficiency projected to be between 92 and 95 percent.

The secret of effective collection is surface area. Only one gram of the fine carbon dust presents a total surface area of more than 70 square meters to incident solar radiation. The black color of the carbon dust absorbs the thermal energy in intense light; certain carbon dust particles less than one micron across have the ability to absorb moderately concentrated sunlight so efficiently that they self-vaporize in milliseconds. A series of experiments led Mr. Hunt to select carbon black as the current best candidate for heat absorption in SPHER. The best source for the material could be the soot from a rich-burning flame.

The challenge remained to fashion a device that would make practical use of the dust's prodigious heat-gathering properties. A small laboratory demonstration unit emerged in which high-intensity lamps substitute for concentrated sunlight shining into a chamber filled with carbon black dust and pressurized air; a larger prototype is under construction. The particles absorb the thermal energy in the light, vaporize, and release the heat to the confined air. According to a report in the *LBL Newsmagazine*, the air in a larger machine using this principle of operation could reach "pressures and temperatures matching those inside a jet engine, conditions capable of driving a conventional [gas] turbine to generate electric power."

Careful design and optimal choice of dust type would enable the particles to

Top: How the price (1980 dollars) of solar photovoltaic modules — interconnected groups of cells — will drop by 1989, according to the U.S. Department of Energy. *Bottom:* Costs incurred in the installation of solar photovoltaic systems. These "balance-of-system" charges are not likely to become cheaper. (*Data: A. J. Cox and T. Dinwoodie*)

"perform their heat transfer chore and then oxidize in a drift region after passing through the chamber," says Mr. Hunt. This strategy would keep pollutants from reaching the turbine blades — or the atmosphere.

Mr. Hunt envisions a 10-megawatt plant based on a large, ceramic-lined, metal SPHER with fused silica windows and a system of heliostats, or sun-concentrating mirrors, that would focus on the SPHER portals. Such a solar plant is projected to consume only about 30 pounds of carbon black dust hourly. A cheaper hydrocarbon diet is hard to imagine. (For comparison, a 10-megawatt coal-burning plant consumes about 600 pounds of coal hourly at its rated output.) According to estimates made at Sandia Laboratory, such a SPHER plant should operate more cheaply than generating plants that burn coal, oil, and natural gas.

Still to be confronted, however, are the technological uncertainties involved in building a SPHER large enough to generate electricity commercially. And there remain nagging economic uncertainties about the capital costs of building and operating a full-scale version.

Mr. Hunt is optimistic on both counts. "We're talking about glass and metal, plastic reflectors, heat chambers, and heat engines — things you can buy off the shelf. It isn't difficult to work out the costs of those things," he says. — *L.A.P.* ☐

Solar Cells: Profound Economic Barrier?

How economically promising — if achievable — are the goals set by the Department of Energy for the costs of photovoltaic power systems in commercial and industrial applications? Not very, in contrast with optimistic forecasts for the residential sector, according to Alan J. Cox and Thomas Dinwoodie of the M.I.T. Energy Laboratory.

Earlier this year Mr. Cox told the fourteenth Photovoltaics Specialists Conference in San Diego that "at rates of return usually found in the industrial and commercial sectors, photovoltaic investments will not be attractive [compared with other potential uses for the capital] based on the Department of Energy's cost goals for 1986."

DOE has established a schedule that calls for photovoltaic systems to be commercially ready in 1986 at a cost of $1.60 per peak watt output (all figures are in 1980 dollars). The modular arrays of the photovoltaic cells themselves are to account for $.70 of this figure. (A photovoltaic *system* consists of photovoltaic arrays and the structures needed to support them and to carry the electricity to its tasks.)

But for large-scale private applications, the cost of a photovoltaic system will probably have to be much cheaper. For a typical application in a bank in Phoenix, Arizona, which uses 142,000 kilowatt-hours of electricity annually at a utility rate of $.064 per kilowatt-hour, Mr. Dinwoodie's computer model OESYS (optional energy system simulator) projects that the "break-even capital cost" under normal business and meteorological conditions would be $.87 per peak watt output.

The economic break-even point becomes more attainable with very large tax benefits and significantly lower expected profits. If *all* the conditions in the following scenario were met, OESYS indicates that a photovoltaic system costing $1.60 per peak watt could achieve economic break-even status.

☐ The bank's real (after-tax) internal rate of return would have to drop from an assumed 7.5 percent to 5 percent.

☐ The investment tax credit of 10 percent on the solar equipment would have to double.

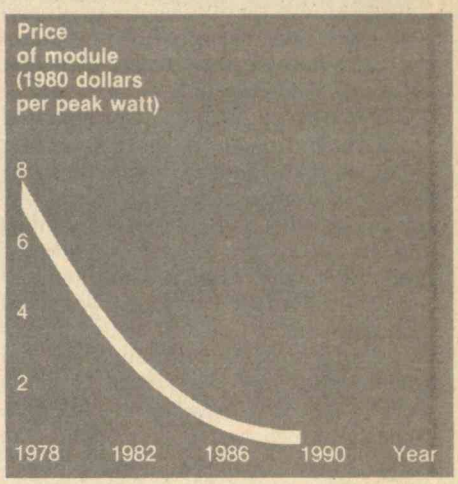
☐ The electric utility would have to buy back excess electricity from the bank's photovoltaic system at a rate of $.032 per kilowatt-hour.

☐ The photovoltaic system would have to function for 20 years at an average efficiency of 86 percent.

☐ Annual operating and maintenance costs would have to be less than $1.50 per square meter of array.

☐ Depreciation of the equipment would have to be "accelerated," that is, weighted most heavily toward the earlier years, not currently allowed.

DOE does not expect significant breakthroughs in so-called "balance-of-system" materials and their costs (*see table*). Even excluding power conditioning and electrical storage, such costs are estimated at $71.54 per square meter of array. (One square meter of today's silicon solar cells can typically generate about 100 watts; *see "Solar Cells: Plugging into the Sun," September 1978, p. 14*). And DOE expects the cost of the cells themselves to decrease only $.20 per peak watt by 1989.



"Balance Of System" Item	Cost (1980 dollars per square meter of array)
Steel frame: materials	$11.48
Steel frame: galvanizing	2.10
Steel frame: fabrication	4.76
Gaskets	.98
Ground connection	1.68
Assembly costs	5.04
Shipping costs (U.S. average)	.98
Installation costs	2.80
Cost of structure that holds panel in place	13.72
Foundation concrete	28.00
Total	$71.54

According to Messrs. Cox and Dinwoodie, that just won't be good enough for the commercial and industrial sectors. — *L.A.P.* ☐

How to Reduce Gasoline Lines

Gasoline lines may represent a form of constraint on gasoline consumption, but they are inherently unproductive. Nobody wins; their cost in lost time simply cannot

be recovered. Given that rationing and increased gasoline taxes are unpopular with legislators, are there other more acceptable constraints that could be invoked to reduce gasoline lines when the next "shortage" materializes?

There are, say Nancy S. Dorfman and Ian E. Harrington of the M.I.T. Center for Transportation Studies, although none induces consumers to cut back on gasoline use as efficiently or equitably as rationing and gasoline taxes. Three examples of constraints with benefits from reduced queueing time that will probably exceed their costs are:

☐ Firms with over 100 employees and government work sites with over 50 workers would be required to take steps — such as encouraging car pooling, van pools, "work-at-home" plans, public transit subsidies, and bicycling — to induce voluntary reductions in gasoline consumed. The M.I.T. researchers calculate that $500 million expended in these efforts could reap savings between $2 and $6 billion worth of gasoline that would otherwise be wasted in gasoline lines.

☐ Each U.S. household would be required to display a sticker on its automobiles indicating one day of the week on which they could not be operated. The resulting decrease in gasoline use could be as great as 250,000 barrels per day (about 4 percent of retail gasoline sales), and could save more than $20 billion worth of gasoline otherwise consumed in gasoline lines.

☐ The use of recreational vehicles — boats, private planes, and off-road vehicles — would be banned on weekends. The cost in lost use of investments in these vehicles would be several billion dollars per year, not counting the indirect losses to industries that supply and service recreational vehicles. But daily savings of gasoline could reach 50,000 barrels nationwide, leading to annual queueing time savings worth about $5 billion.— *J.M.* ☐

Space Exploration

Venus: Earth's Schizoid Sister

"The principal discovery is . . . a highly variable topography that seems to be isostatically compensated." The speaker is Harold Masursky, geologist with the U.S. Geological Survey; the subject, further analysis of the surface of Venus based on data compiled over the past year and a half by the M.I.T. radar altimeter on board the *Pioneer-Venus 1* (*see "Venus Unveiled," February 1980, page 78*).

When a planet is isostatically compensated, its outermost layer, the lithosphere, literally floats on an underlying denser but structurally weaker (more plastic) layer — the asthenosphere. If a region of lithosphere is especially thick, it extends both farther above (forming a mountain or plateau) *and* down into the asthenosphere; any floating object will displace its weight in the suspending medium.

But how and when regions of the crust of Venus came to be unusually thick remains in question — the achievement of isostasy takes time. Thus, all other factors being equal, the greater its gravitational anomaly, the less compensated and younger a feature is likely to be; conversely, the smaller its anomaly, the more nearly compensated and older it is. Measures of isostatic compensation can also provide hints about the thickness of the lithosphere and the relative strength of the asthenosphere. Unfortunately, the interpretation of raw gravity data is complicated by the fact that the instrumentation may "sense" that a fully compensated high feature exerts a stronger gravitational force than a similarly compensated but less elevated feature, simply because the higher feature is closer to the spacecraft. Correcting for this effect involves making assumptions, for example, about the density of highland rock and the depth of its root.

Overall, Venus is at least close to being fully isostatically compensated, as is Earth, according to Roger Phillips of the Lunar and Planetary Institute of Houston, principal investigator of the *Pioneer-Venus* gravity-measuring experiment. But even *partial* compensation is significant, since Venus shows great plateaus and other highlands, yet may not have global plate tectonics — though there's plenty of evidence of current local activity. When added to what we know of the planet's surface from the findings of the Soviet *Venera 8* landers, this conclusion helps determine the overall structure of the planet's surface.

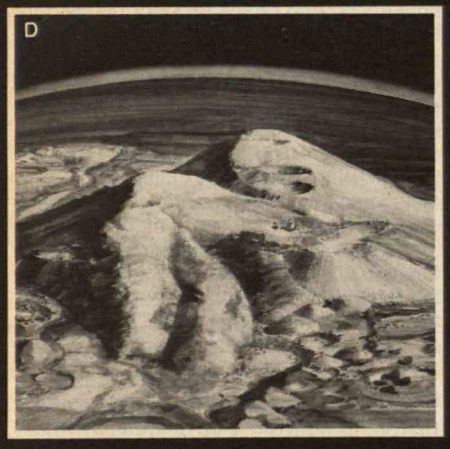
It is tempting to hypothesize that the crust of Venus is comprised of two major rock components, like Earth's granitic continents and basaltic ocean basins. *Venera 8* landed on the upland plain, which covers about 65 percent of the planet's surface, and measured a radioactivity level like that of granite. If this vast upland (referred to as "lowland" in "Venus Unveiled") is analogous to Earth's ancient, granitic continents, can the extensive, nearly featureless lowlands (now defined as regions of the surface of Venus more than one and one-half kilometers below the average elevation) be analogues of our ocean basins? If so, there are only two explanations likely for the configuration of the planet's three distinct highlands, those regions significantly higher than the upland plain.

Since the highland rock is apparently isostatically compensated, it must either be less dense than the upland rock or very thick, with roots that penetrate deeply into the asthenosphere. Thus, if Beta Regio is, as the radioactivity measurements of *Venera 9* and *10* suggest, a huge volcanic construct of basalt, which is denser than granite, it must have deep roots. But Aphrodite Terra and Ishtar Terra do not appear to be like Beta Regio; and no rock less dense than granite and abundant enough to comprise these huge regions is known on any other planet. Their isostatic compensation may then imply that they have deep roots, suggesting the same is true for plateaus on Earth, the origins of which are still unclear.

Mr. Masursky tentatively suggests that the vast upland is the oldest major feature on the surface of Venus, if the many circular features are impact craters. He suspects that there has to have been active vulcanism on Beta Regio as little as 100 million years ago; it quite likely continues today. Recent or current tectonic activity is likely on the periphery of Aphrodite Terra, evidenced particularly well in its two great eastern rift valleys.

These valleys (*see "The Venus Invasion," March/April 1979, p. 69*) have shoulders higher than the valleys are deep, rather like the topography of Earth's mid-ocean ridges caused by plate tectonics. Mr. Masursky speculates that the two rift valleys may be "volcanic-constructional, or perhaps indicate early compression and later tension." But lest the conclusion be drawn that they are evidence of plate tectonics, it should be noted that one valley is almost circular, an unlikely shape for a spreading ridge.

Thus, Venus, like Earth in its degree of isostatic compensation, seems also to have an apparently discrete distribution of rock types similar to that of the geologically inactive Moon. "Venus seems to be totally schizoid," says Masursky. "It's different from any other terrestrial planet." — *Jim Loudon* ☐



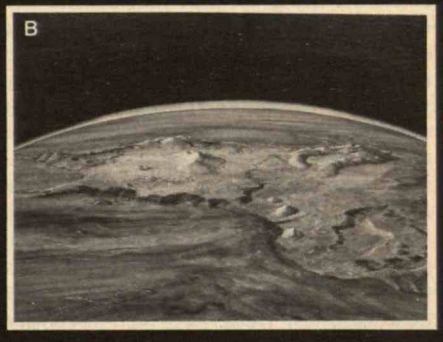
This shaded relief map of Venus was compiled from *Pioneer-Venus 1* radar altimetry. Surrounding the map are paintings of four prominent regions of the planet. The artist has stripped away the cloudy atmosphere that shrouds the surface of Venus and has exaggerated slopes and heights — a true portrayal wouldn't show them at all. The greatest slopes on Venus are the 7-degree walls of Diana Chasma and the mountains of Ishtar Terra.

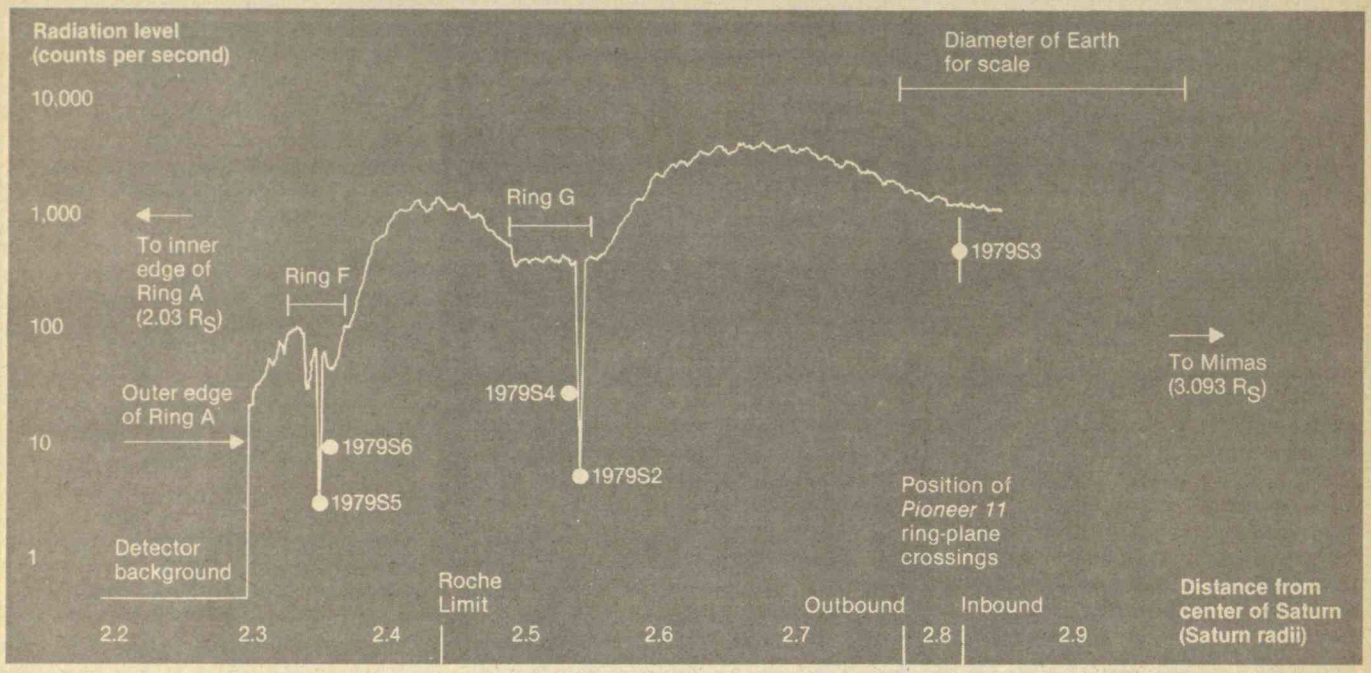
A: Ishtar Terra, a high plateau containing several mountain ranges, about the size of Australia.

B: Aphrodite Terra, the largest highland, about 6,000 miles long and 2,000 miles wide. The western mountain range rises about 23,000 feet above the surrounding terrain; the eastern range rises about 10,000 feet.

C: Diana Chasma (tentative name), the great rift valley complex at the east of Aphrodite Terra. The main rift in the center is about 175 miles wide and 1,400 miles long.

D: Beta Regio, apparently two huge shield volcanoes situated on a north-south fault zone that covers a combined surface area greater than that of the Hawaii-Midway chain. (*Photo: NASA Ames Research Center; drawings: Rick Guidice, NASA Ames Research Center*)





This diagram shows how one radiation detector aboard *Pioneer II* found radiation to vary with distance from Saturn. Note the absorptions attributed to rings and moons. Positions of suspected moons that show up in other records are also indicated. Distances are in Saturn radii (by convention, the radius of Saturn is set at 60,000 kilometers — 37,282 miles). The positions of several suspected new moons are indicated by legends showing the year of tentative discovery and an index number, e.g., I979S5. Mimas is the innermost of Saturn's "classical" moons — those known before 1966. The Roche Limit is the distance within which Saturn's tidal forces would tear apart any moon bigger than about 300 miles in diameter; its position is a function of a moon's density, here shown for the density of ice. (*Data: Professor James Van Allen, University of Iowa*)

Saturn: New Moons by New Means

The number of Saturn's moons is still uncertain. During the past year several new ones have been found, but duplications exist, and the final count is yet to be determined. One sure bonus: at least one previously unknown ring has been identified, and the likelihood is that a second has also been found.

Some of the new moons were discovered last September by *Pioneer 11* (the first spacecraft to visit the planet) using "particle-beam astronomy" techniques. Other discoveries are from Earth-based observatories, most of which used new electronic light-detecting devices of unprecedented sensitivity never before used to search for new worlds.

Spacecraft observations. "Particle-beam astronomy" is a term invented by James Van Allen, professor of astronomy at the University of Iowa, who helped determine the existence of a magnetosphere around Saturn from *Pioneer 11* data, and indeed who has been involved in the discovery of every known planetary magnetosphere. Within planetary magnetospheres are radiation belts, vast regions where subatomic particles trapped in orbit spiral around the lines of the planetary magnetic fields at nearly the speed of light.

A moon in such a radiation belt absorbs subatomic particles, carving out a detectable "hole" of greatly decreased radiation levels.

Pioneer 11 flew through such holes for every previously known Saturn moon close enough to the planet to be within its magnetosphere. And it also detected several additional holes, which Professor Van Allen interprets as due to the presence of heretofore unknown moons. If so, these moons are the first planetary satellites ever "discovered" by a spacecraft. However, the actual discovery is still literally in the eye of the human beholder. For example, human investigators discovered new Jovian moons from data collected by the two *Voyagers* before Professor Van Allen made his determination from *Pioneer 11*'s data, but their discovery followed his. For now, it's the *evaluation* of data from spacecraft that marks the discovery of phenomena in space.

Saturn's three main rings absorb radiation even more effectively than its moons because the total surface area of material within the rings is far greater. When *Pioneer 11* passed under the outermost of the three main rings (the A ring), radiation levels fell lower than those measured by the spacecraft while sitting on the launch pad. But just beyond the three main rings, the spacecraft detected two additional regions of absorption, the innermost of which Professor Van Allen says is definitely a previously unknown ring, the F ring, which was corroborated by the spacecraft's cameras. The outer region of absorption may also be a ring, but it is too thin to be seen by the cameras. Investigators tentatively call this the G ring.

Two startling consequences of the absorption of radiation-belt particles by Saturn's rings and moons have been suggested: human expeditions may travel to the vicinity of Saturn long before they go to Jupiter, despite the fact that Jupiter is only half as far from Earth; and Saturn's three spectacular main rings should be mildly radioactive.

Earth-based observations. During the past year, many observations of an undetermined number of previously unknown objects orbiting Saturn were made from Earth with new, sensitive instruments. At

the time, Earth was passing through the plane of Saturn's rings, an event that occurs only once every 15 years. Seen edge on, the rings appear nearly invisible; indeed, they are the thinnest objects for their extent known in nature. A scale model of them made of tissue paper would cover at least a football stadium! The moons, which are just outside the rings and normally drowned out by their glare, are rendered much more easily visible under such conditions. However, the existence of a new moon is proved by a precise determination of its period, according to Brian Marsden director of the Central Bureau for Astronomical Telegrans of the Smithsonian Astrophysical Observatory (the world clearinghouse for observations of new astrophysical objects). The complete orbital revolutions of Saturn moons can't be followed from any one Earth observatory; rather, they must be assembled from numerous observations, a difficult job at best.

Saturn's F and G rings (the latter still tentative) seem to contain one or more moons. These rings are much narrower and less dense than the main rings of Saturn, and may have a different origin. One theory is that they consist of debris produced by the impact of meteoroids and radiation on the associated moons. If the gravity of such small moons couldn't hold the debris, it would escape along the orbital path to form such very narrow rings.

Some people were afraid *Pioneer 11* would be destroyed as it crossed the E ring (a suspected faint outer extension of Saturn's ring system). It wasn't, conceivably because a new moon carved a hole that by sheer luck allowed the spacecraft to pass through safely. No object has yet been conclusively discovered in this region, although Pioneer observations suggest one may exist.

Far beyond the rings, at least one new moon has been reported near the orbit of Dione, Saturn's fourth "classical" moon. Another possible moon has been reported by French astronomers well beyond the G ring. A number of additional, miscellaneous Earth-based observations of possible moons exists that can't yet be resolved because of insufficient data.

Voyager 1 is due to arrive at Saturn this November and *Voyager 2* in August 1981. Both will make extensive searches for moons as they approach the planet. If they fail to resolve the uncertainty that now exists, it will be a long time before astronomers can answer the simple question: "How many moons does the planet Saturn have?" — *Jim Loudon* □

Life: Patent Pending ...

For patent law purposes, it is of no consequence that an invention is alive, according to the U.S. Supreme Court. "The relevant distinction," wrote Chief Justice Burger for the majority decision in *Chakrabarty versus Diamond*, is "not between living and inanimate things, but between products of nature, whether living or not, and human-made inventions."

Thus, a newly discovered but naturally occurring species of plant or animal is not patentable; however, one created in the laboratory is. And Amanda M. Chakrabarty's living microorganism, which he designed and created to consume petroleum and thereby control oil spills, is entitled to patent protection.

How profound are the implications of the Court's decision for the future of genetic research and for society? One view is that in deciding that a living creature is a "manufacture" or "composition of matter" for patent purposes, the court has reduced matters of life to inanimate physics. There are reasons to believe, however, that the implications of the Court's decision are not far reaching.

Chief Justice Burger's reasoning in *Chakrabarty* does not come to terms with the fundamental philosophical and metaphysical issues in genetic engineering. The decision was a common-sense, pragmatic approach to the legal problems involved in this specific case.

The case has no constitutional significance and therefore could be overturned by Congress. Indeed, any substantive debate over genetic engineering simply has been postponed by the Court's action. In the end, society as a whole will have to decide how to regulate that capability. — *William Lasser* □

. . . Implications for Research

When the Supreme Court ruled in June that existing federal law allows for the patenting of manufactured organisms, the outcry from academic and scientific sectors was loud and fervent.

"Patenting of life forms is a dangerous precedent, not for spiritual reasons but because modification of the ecosphere has dangerous implications," says M.I.T. molecular biologist Jonathan King, longtime follower and commentator on the controversy. "The life of humans depends on the interaction of all organisms, too important a resource to be owned by corporations interested in maximizing a return on their investment rather than net social benefit."

The focus of Professor King's most immediate concerns is the potential of this ruling for encouraging the patenting of food plants. While certain "show" flowers such as varieties of orchids and roses have been patentable since the 1930s, most food plants have traditionally been considered off-limits by the U.S. Patent Office.

"In Europe, the large conglomerates have pushed through legislation to allow patenting of food plants and to suppress wild varieties of plants," Professor King says. This has caused some plant varieties to disappear in Europe — in fact, a National Academy of Sciences study says that three-quarters of the total food crop varieties there will be lost by 1991."

Professor King believes the widespread patenting of edibles could prove disastrous to the world's food supply. Decreased plant diversity reduces the opportunity for cross-breeding essential to continued agricultural health, and increases the opportunity for a small handful of pest varieties or diseases to knock out a nation's entire food crop.

The most immediate application of the Supreme Court's decision, however, is to enable the engineers of new microorganisms to protect their discoveries with patents. Scientists have recently developed methods of altering the genetic structure of microbes to induce them to do a variety of useful tasks from manufacturing insulin to gobbling up oil slicks. More than a dozen small companies, many capitalized by major corporations, have sprung up to investigate, develop, and profit from various ways of applying this technique. However, representatives of several of these concerns said the patent decision would have little impact on their continued viability.

"It's nice that we can patent, but in no way would it have been a disaster had the decision gone the other way," said Ronald E. Cape, cofounder and chairperson of Cetus Corp. of Berkeley, Calif., one of the nation's oldest and largest biotechnology firms. He and others in the new industry said their field is advancing so quickly that patents aren't really necessary — by the time a competitor deciphers a trade secret it will already have become obsolete. However, others, like Professor King, warn that patents will give industry the opportunity to make money on research

funded primarily by public funds.

"Patents will make the public buy back what (its money) has already developed," Professor King complains. "If we allow patents at all, they should at least remain in the hands of the public sector, which paid for them."

Mr. Cape agreed that the potential for irresponsible exploitation, or even "theft," of organisms developed in university laboratories is real. He warns that at least one company had already made claim to a "discovery" announced months before by an academic researcher writing in a professional journal. However, he added that Ph.D.'s working on biotechnological applications had, after all, received their training at universities, and most were unwilling to risk their name and their company's by stealing what is rightfully public property.

"We hope to establish a reciprocal relationship with universities," Mr. Cape told *Technology Review*. "We will pay royalties to them for any techniques that we use in our laboratories. In fact, we are already paying royalties to Stanford. I think universities have to become more aggressive about demanding these royalties. The last thing I or those working with me want to do is rip off the public."

While the patent controversy has prompted a growing interest in applications of biotechnology such as the production of human hormones, petroleum, and alcohol, basic research will continue to be supported by public funds. Industry is interested in pursuing what will ultimately prove profitable, not in the risky exploration of novel techniques and theories. Therefore, experts involved with rapidly evolving science caution that private investment in biotechnology must not supplant the expenditure of public funds.

"The small companies don't have the money to put into nondirected research," M.I.T. virologist David Baltimore told the *Boston Globe*. "The companies that can afford to give lip service to the idea, but very rarely money." Professor Baltimore suggests that industry pay a "tithe" to universities in the form of support for basic research that leads to the creation of a marketable product. But he firmly believes that public support is crucial if the science is to survive and thrive.

"The whole patent issue doesn't really change anything," he said. "Industry will still be reluctant to support basic research. Public commitment to support such work is crucial. Any break in that commitment, any loss of funds or lack of stability, will be terribly disruptive." — *E.R.S.* □

Knowledge of Wild Plants Going Underground

During the seven-year drought from 1965 to 1972, the Tlokwa, agro-pastoralists of the eastern Kalahari in Botswana, fed themselves on 150 kinds of porridge made from cultivated cereals and on 250 species of gathered foods. But should another drought parch their semiarid territory, survival might not be so likely.

The Tlokwa are typical of peoples caught in the inexorable movement of the less-developed countries (LDCs) toward "modernization." A fundamental activity for developing nations is the creation of a strong agricultural sector. For a variety of reasons, agriculture has led former hunter-gatherer societies away from the use of some 1,500 species of edible wild foods that provided generations of forebears with a variety of nutrients. Farming pushes back the bush, and many farmers concentrate their efforts on cash crops. This is an old story in the industrialized nations, where foraging has been relegated largely to nature buffs, scouting, and survival trainees, but has only recently started to affect the LDCs.

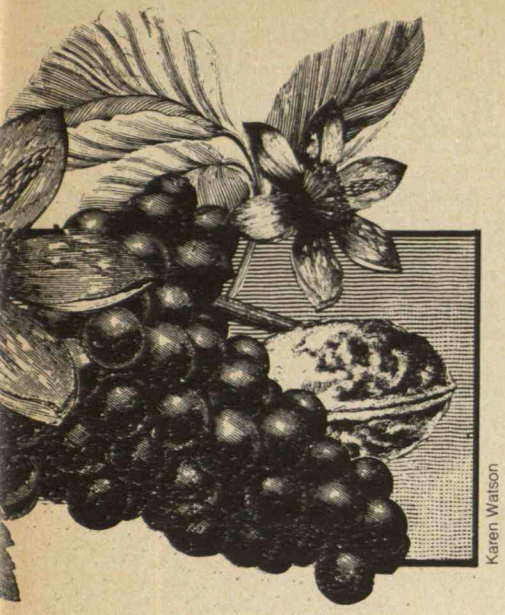
"The newer generations tend to forget the old ways, considering it backward to use wild plants," writes Joyce Doughty of the London School of Hygiene and Tropical Medicine in *Appropriate Technology*. She offers several serious implications for such societies:

☐ The ability to recognize and prepare wild plants is being lost. Only about 500 wild food plants today support extant hunter-gatherer societies worldwide.

☐ The knowledge of how to use wild plants during adverse circumstances is disappearing.

☐ Knowledge of traditional, nutritious mixtures of wild foods is being lost. For example, "dashes" of certain "pot herbs" provide essential nutrients, but use of such plants is disappearing with the adoption of more "modern" recipes.

☐ Gene pools of indigenous plants are threatened by the spread of modern agriculture. Such plants "have adapted to adverse conditions to a remarkable degree, and people should use this adaptability instead of losing it," according to Dr. Doughty. It's a case of putting all your seeds in one basket: should hybrid strains



Karen Watson

succumb to the onslaught of a particular infestation of insect or disease and no hardy natural alternative plant be available to replace or rebreed the hybrid, starvation could be the result for dependent users.

Concludes Dr. Doughty: "Modern crop pathologists are finding that the practices of many subsistence farmers in developing countries, who believed in planting a selection of seeds rather than uniform ones, are not as careless and haphazard as once thought." — *L.A.P.* □

Last Line

Dial-an-Expert

Dating services, personal newspaper ads, and diverse institutions ranging from the village matchmaker to the exotic retreats immortalized by journalist Gay Talese have at least two things in common: they are based on the belief that if you want to meet someone, there is a Mr. or Ms. Right to satisfy your specifications; and they fill the critical need for a "middleperson" to help bring the right people to the right place at the right time. More simply, and in the argot of our time, they facilitate "communication."

The real business of communication — "the media" — has had its own problems, and criticisms, in recent years for failing to be in the right place, for frequently being overrepresented in the wrong place, and for journalist/source couplings that are often hasty, arbitrary, and unhappily consummated. Too many statements from inappropriate or injudicious experts get into print or on the air, while too few citations are garnered from the proper sources, say some critics. And in no area have criticisms of the media been more strident than in science and technology reporting. Journalists — generally without scientific expertise of their own — must locate the appropriate specialists to explain things and "set the record straight." But like so many lonely yet potentially compatible singles, journalist and expert are too often ships that pass in the night. There have been no well-defined mechanisms for routinely bringing them together.

The Scientists' Institute for Public Information (SIPI) — a nonprofit, New York City-based clearinghouse for achieving what its name implies — has recently jumped into the breach. It has launched the Media Resource Service (MRS) to bring journalists and scientists together. "Why hasn't anyone done this before?" is the recurrent question among the service's many respondents, astonished that it is the first serious national attempt to establish such a basic and important institution. Walter Cronkite, who has given his support to the MRS, paraphrases Voltaire's famous remark on an even higher authority: "If it didn't exist, we'd have to invent it."

Already in possession of a small but reliable file on communications-oriented scientists, SIPI's referral service began, informally and unofficially, a week after the accident at Three Mile Island. It continued to function thereafter as reporters learned of its existence (chiefly by word of mouth) and phoned in their requests. By the time the MRS was formally announced this past winter, the nascent service gave signs of growing up: it secured grants from the Ford Foundation and the Rockefeller Family Fund, as well as smaller gifts from many other supporters; it was prominently mentioned in *Science* and elsewhere; and it received a sizeable number of unsolicited offers from scientists who wished to participate.

But the most promising sign was the fruitful return of inquiries mailed to leading scientists, universities, research centers, and professional associations to acquire a full complement of fields and points of view. "We expected a mixed response at best," says Fred Jerome, SIPI's public information director. "The old image of scientist as ivory-towered recluse led us to anticipate a high percentage of brusque rejections from experts 'too busy' to be bothered answering questions from the media. But the response has been nothing less than phenomenal."

The initial mailing of 3,000 questionnaires yielded 1,500 returns, often accompanied by encouraging letters. Only two scientists actually said they were "too busy." As of this writing, over 2,000 scientists have officially signed up. "I don't believe this is an instance of publicity seekers looking for 'ink' or TV appearances," adds Mr. Jerome. "Without overstating the case, I think it's fair to conclude that within the once-withdrawn scientific community, a new awareness is developing: of the importance of *public* awareness."

There are problems, of course. Many "scientific" questions are not easily categorized, and the appropriate experts may not be readily identifiable. The search for balanced viewpoints on highly politicized issues may well be elusive. It will not be easy for journalists to trust scientists they know little or nothing about, or for scientists to answer the questions of an unknown interviewer with full candor. And maintaining financial support may prove the biggest challenge of all: even the most well-intended participation in a controversial issue may make some sponsor angry.

The MRS staff is confident, however. Says Mr. Jerome: "The recognition of these problems is at least half their solution. The rest will come with experience." — *S.J.M.* □

Solution to June/July Crostic

A remarkable aspect of this ongoing orogenic event is that the Indian craton continues to drive headlong into Asia at the rate of five centimeters per year, upthrusting high jagged* mountains over an area of ten million square kilometers, without itself deforming.

*added

Thomas H. Jordan, "(The Deep Structure of) the Continents," Scientific American, January 1979

A. Tintagel	N. Trurl
B. Hof	O. Heifer
C. Oneupmanship	P. Escapement
D. Mansuetude	Q. Chondrite
E. Atherosclerosis	R. Orvieto
F. Santorini	S. Nootka
G. Houyhnhnm	T. Tottles
H. Jacquard	U. Irvine
I. Osteoma	V. Novitiate
J. Raff	W. Eka-Iodine
K. Digging the Weans	X. Nictitate
L. Aggravate	Y. Trireme
M. Negligible	Z. Stroganoff

Letters/Continued from page 2

of regulation are applied and the nation's resources irrevocably committed.
Jerome T. Coe
Greenwich, Conn.

Contrary to what Dr. Epstein chooses to believe, we in industry do care about the safety of the general public and the worker. The American Industrial Health Council (AIHC) is not against scientifically sound management of carcinogens in the workplace. To achieve this, AIHC suggested that a panel of independent (not governmental or industrial) scientific experts be set up to determine a substance's ability to cause cancer. The panel would be named and supported by a prestigious scientific organization such as the National Academy of Sciences.
Ronald A. Lang
Scarsdale, N.Y.

The writer is executive director of the American Industrial Health Council. —Ed.

The Economics of the CAT Scan

Mr. Rettig (in *"The Changing Federal Role in Medical Technology," February, p. 34*) fails to calculate the economic savings realized by performing a CT scan early in a diagnostic workup. This procedure, though costing upwards of $250, often replaces conventional radioisotope scans, hospitalization, and expensive invasive procedures such as angiography and exploratory surgery.
Richard P. Handler, M.D., M.A.C.P.
Saranac Lake, N.Y.

Classified

The diamond solitaire.

A rare gift.

One single diamond.
Set simply and elegantly, to sparkle on its own.
The diamond solitaire.
A jewel that becomes more precious with
every passing year.
The gift that makes a rare and beautiful
moment last a lifetime.

A diamond is forever.

The 1¼ carat diamond shown is enlarged for detail. DeBeers.

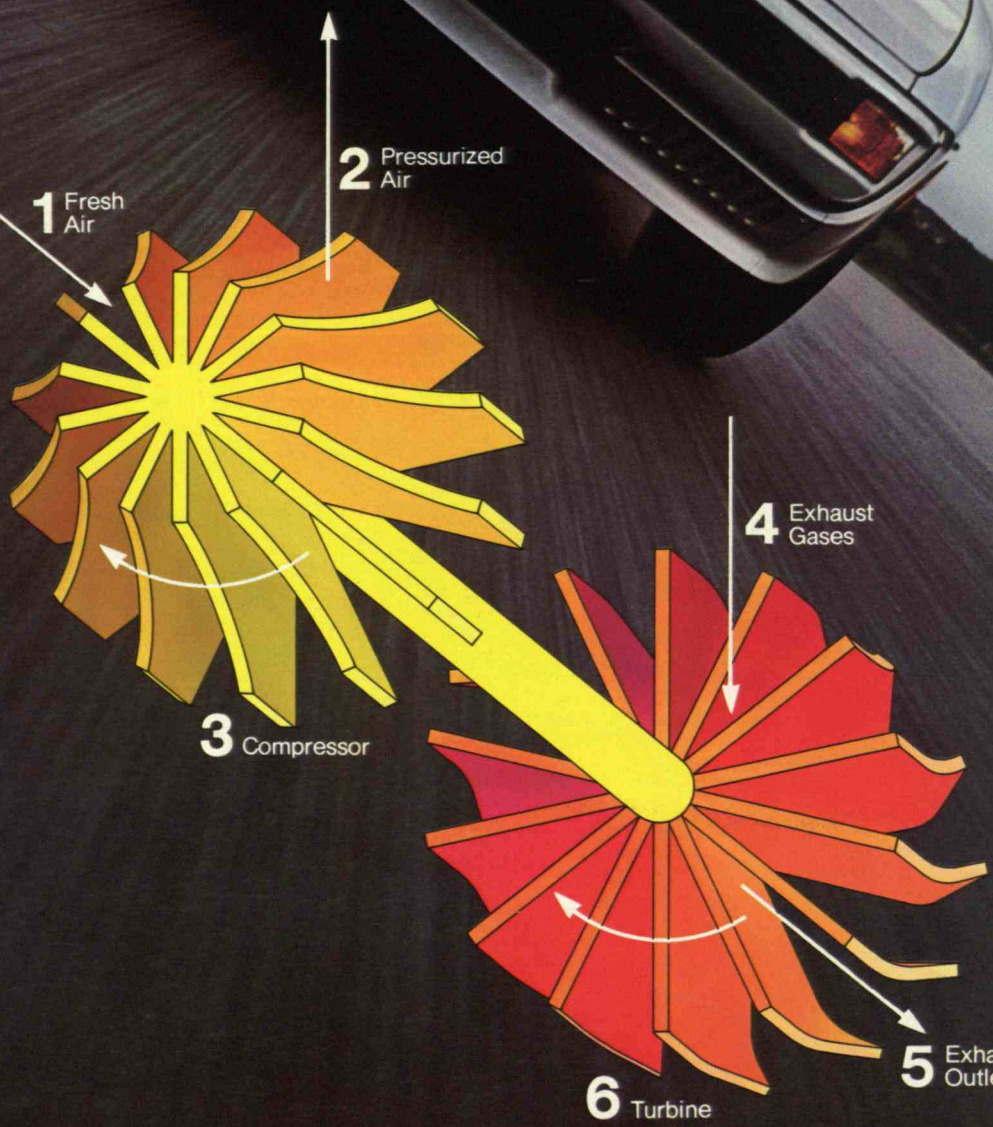
Consumer Orientation
No. 3 in a Series
Subject: Introduction of the Porsche 924 Turbo

3 Porsche 924 Turbo

Porsche+Audi
Nothing Even Comes Close

The Porsche 924 Turbo. On the track at Weissach, it covers the quarter mile from a standing start in 16.3 seconds. Its speed at the ¼-mile mark is 88 mph. Its maximum speed: 132 mph. The 924 Turbo is a direct descendant of the 917 Can-Am champion, the Porsche that made turbocharging practical for road racers. Prior to the 917, turbocharged automobiles suffered from poor throttle response and reliability. But the 917 Turbo solved these problems with its unique bypass valve and wastegate control system—standard equipment on the new 924 Turbo.

1. The KKK turbocharger draws in fresh air.
2. The compressor forces the air/fuel mixture into the engine cylinders under pressure. Because the turbocharged engine receives more air/fuel than a naturally-aspirated engine, its combustion is greater. And its horsepower is increased without increasing its engine displacement. Thus, while the 924 Turbo's engine displaces only 1984 cc, it develops 143 hp at 5500 rpm.
3. The 924 Turbo has almost instantaneous throttle response because of its bypass valve. When the throttle is closed, the valve opens and routes the pressurized air harmlessly back through the compressor in a closed loop. This maintains turbine speed. So when boost is demanded, the turbine does not have to be re-accelerated. Boost is available again in only 0.1 second.
4. Hot, normally-wasted, engine exhaust gases drive the turbine which is connected by a common shaft to the compressor.
5. The gases vent by way of the exhaust line and muffler. A wastegate is located upstream of the turbine to control the excess gases not required to power the turbine.



At Porsche, we design a car as a total system. And so the 924 Turbo has a new cylinder head. A stronger driveshaft. New spoilers: front and rear. In fact, it has the lowest drag coefficient of any street Porsche: 0.35. And as a result of its total design efficiency, it requires only 16.5 horsepower to cruise at 55 mph.

For more information on the 924 Turbo, call toll free: (800) 447-4700. In Illinois, (800) 322-4400.